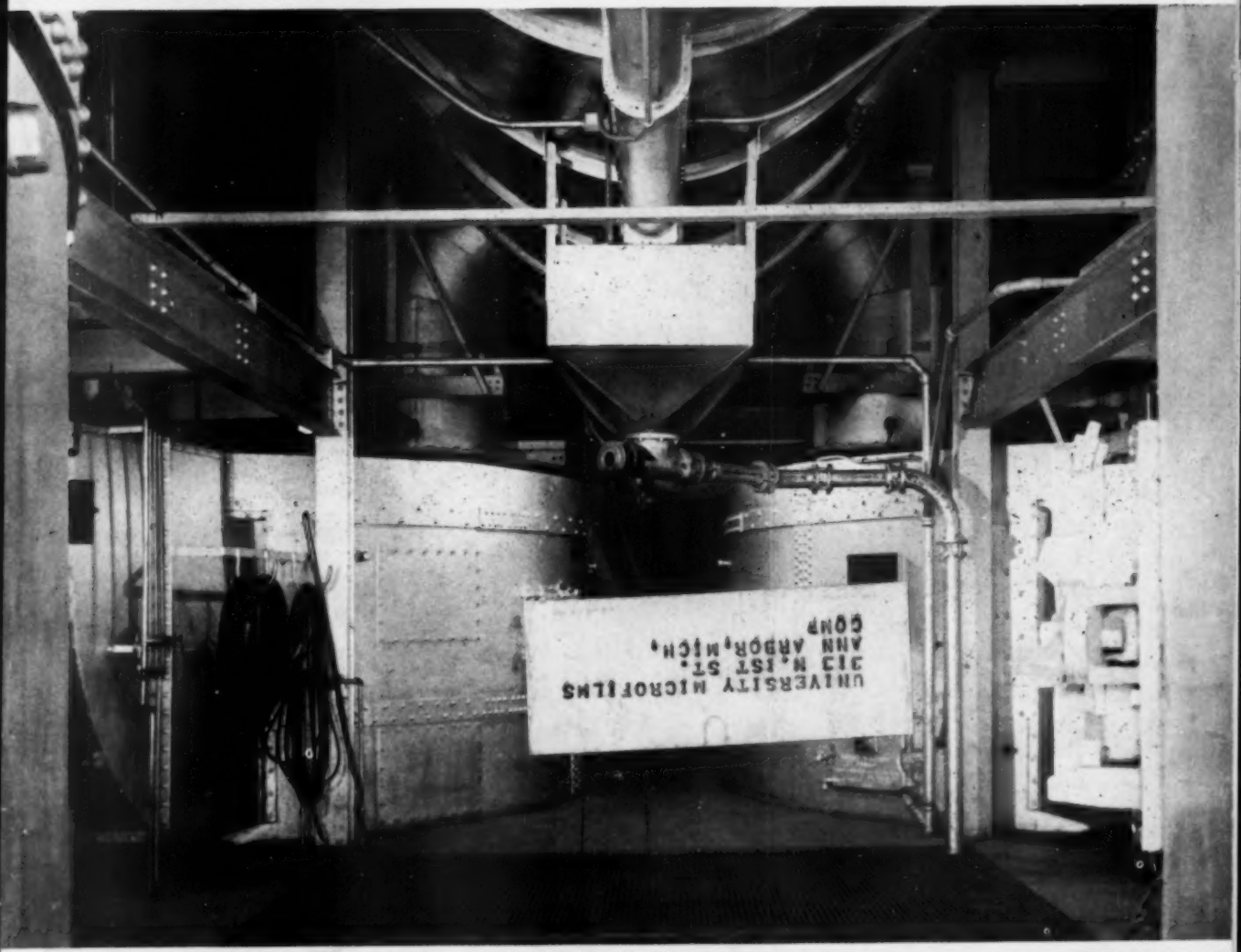
WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication



NOVEMBER
1957

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INVISIBLE WATERTIGHT BARRIER

The glass walls of a modern aquarium form an invisible barrier which contains the many tons of water in which marine life can be observed safely by the public.

An equally watertight barrier, invisible in the finished product, exists in every high pressure Lock Joint Concrete Pipe. It is the impermeable, welded sheet steel cylinder molded into the pipe's dense concrete wall.

Every one of these cylinders is subjected to a rigorous hydrostatic test which places a stress of up to 25,000 psi in the steel. During the test every welded seam is carefully examined for leaks, and only those cylinders which are completely watertight are accepted. This is only one of the many quality control measures observed throughout the production of Lock Joint Concrete Pressure Pipe.

Can you guess approximately how many bodies of average priced automobiles could have been made from the steel cylinders required in the construction of the 254,500′-48″ section of the Saginaw-Midland water supply line? If you're stumped, the answer appears in the picture above.

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Mo. • Perryman, Md.

Pressure • Water • Sewer • REINFORCED CONCRETE PIPE • Culvert • Subaqueous

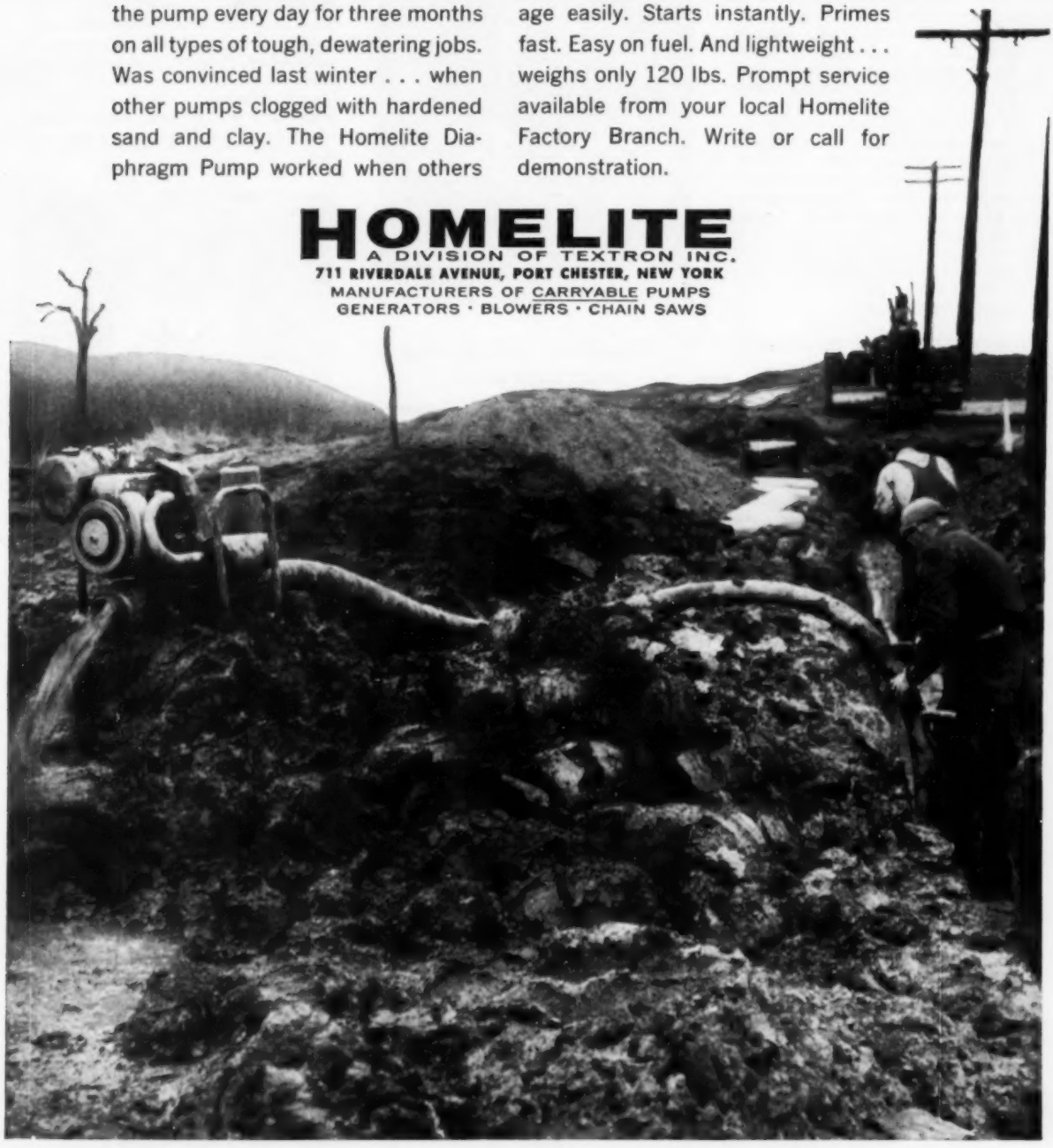
FOR MEN WHO BUY EQUIPMENT FOR WHAT IT SAVES

"Not one dime's worth of maintenance"

Mr. Joe Cloghessy, Pres.
T. F. Cloghessy, Inc.
Hammond, Ind.

That's this contractor's cost record with a Homelite Diaphragm Pump. Zero for maintenance . . . and he used the pump every day for three months on all types of tough, dewatering jobs. Was convinced last winter . . . when other pumps clogged with hardened sand and clay. The Homelite Diaphragm Pump worked when others wouldn't. Handles water thick with mud, sand, clay, gravel freely. Pumps 5,000 gals. per hour. Handles seepage easily. Starts instantly. Primes fast. Easy on fuel. And lightweight . . . weighs only 120 lbs. Prompt service available from your local Homelite Factory Branch. Write or call for demonstration.

HOMELITE
A DIVISION OF TEXTRON INC.
711 RIVERDALE AVENUE, PORT CHESTER, NEW YORK
MANUFACTURERS OF CARRYABLE PUMPS
GENERATORS · BLOWERS · CHAIN SAWS



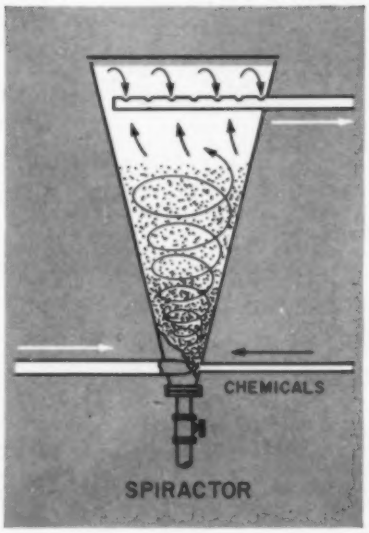
HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 3 OF A SERIES)

Precipitation Equipment

Basically, precipitation equipment converts water impurities to the form of large, dense, suspended particles; then it separates these particles from the water.

The first step is accomplished with chemicals. Hardness, for example, is precipitated by adding lime (and soda ash, if required). The precipitated hardness and other suspended impurities such as turbidity or oxidized iron and manganese are made to coalesce into larger particles by adding alum or iron salts. These salts also form their own dense, floc-like precipitate which absorbs the suspended material to form even larger particles.

The insoluble particles must then be separated from the water. Early methods used settling basins where precipitates settled slowly as the water flowed through, requiring 2 to 4 hours or longer detention time. Modern equipment keeps precipitates in suspension to serve as nuclei on which fresh precipitates form. This results in larger, denser particles that absorb more of the fine particles and are more easily separated from the water.



PRECIPITATOR for removing hardness, turbidity, color, iron, manganese.

Chemicals are mixed with influent at A. As water flows downward through zone B, precipitates form, "seeded" by recirculated sludge. At C, floc has formed a sludge-blanket filter suspended by upward motion of the water. Excess sludge is concentrated and periodically drawn off.

Because of short detention time, capacity is about 4 times that of conventional coagulation and settling basins of the same size. Basic designs include vertical types as illustrated, vertical types for installation in existing tanks, horizontal types built into new or existing concrete basins and smaller "package" types for bottling plants, etc.

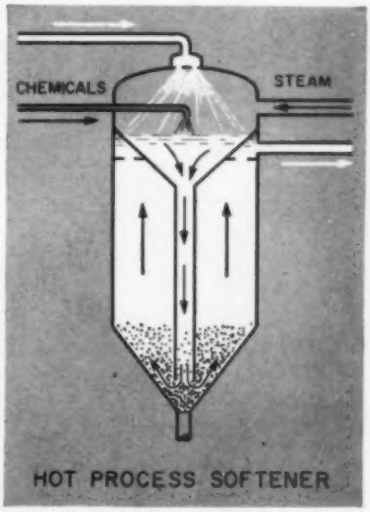
SPIRACTOR® for softening clear hard water.

The water, lime (and soda ash if required) enter at bottom of cone. The treated water rises with a swirling motion and suspends a bed of fine granules of calcium carbonate or other catalyst which speed softening reactions. The precipitated hardness deposits on the granules which become heavy and work down to the bottom of the cone where they are drawn off then easily dried and dumped. The softened water rises above the bed of granules to the outlet.

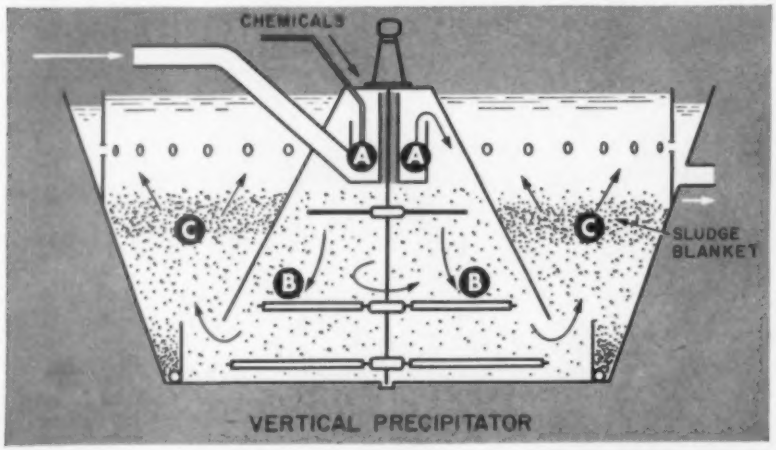
Provides very high flow rates in relation to its small floor space. Detention period: 8 to 10 mins. Recommended for municipal or cooling water.

HOT PROCESS SOFTENER for removing hardness and silica from boiler feedwater.

The water is first heated to within a few degrees of boiling by spraying through steam. Then it is mixed with softening chemicals which react very rapidly and efficiently at this temperature. It then flows down to the bottom and upward through a suspended sludge blanket of precipitated solids which effectively reduces silica and filters out the bulk of the turbidity. Combination softeners with built-in condensate heater and storage compartment and/or steam scrubber (deaerator) are also available.



The effluent is filtered to remove last traces of suspended matter. Where zero hardness is required, Hot Process Softeners may be followed by a zeolite softener.



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For detailed information on these or any other types of water conditioning equipment, write: The Permutit Company, Dept. W-11, 50 West 44th St., New York or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®
rhymes with "compute it"
A DIVISION OF PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

Vol. 104 No. 11

NOVEMBER, 1957

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Water and sewage budgets

As a planner of water and/or sewage plants you know what it means to be in the middle, between a demanding public on one side and budgets shrunk by increasing costs on the other.

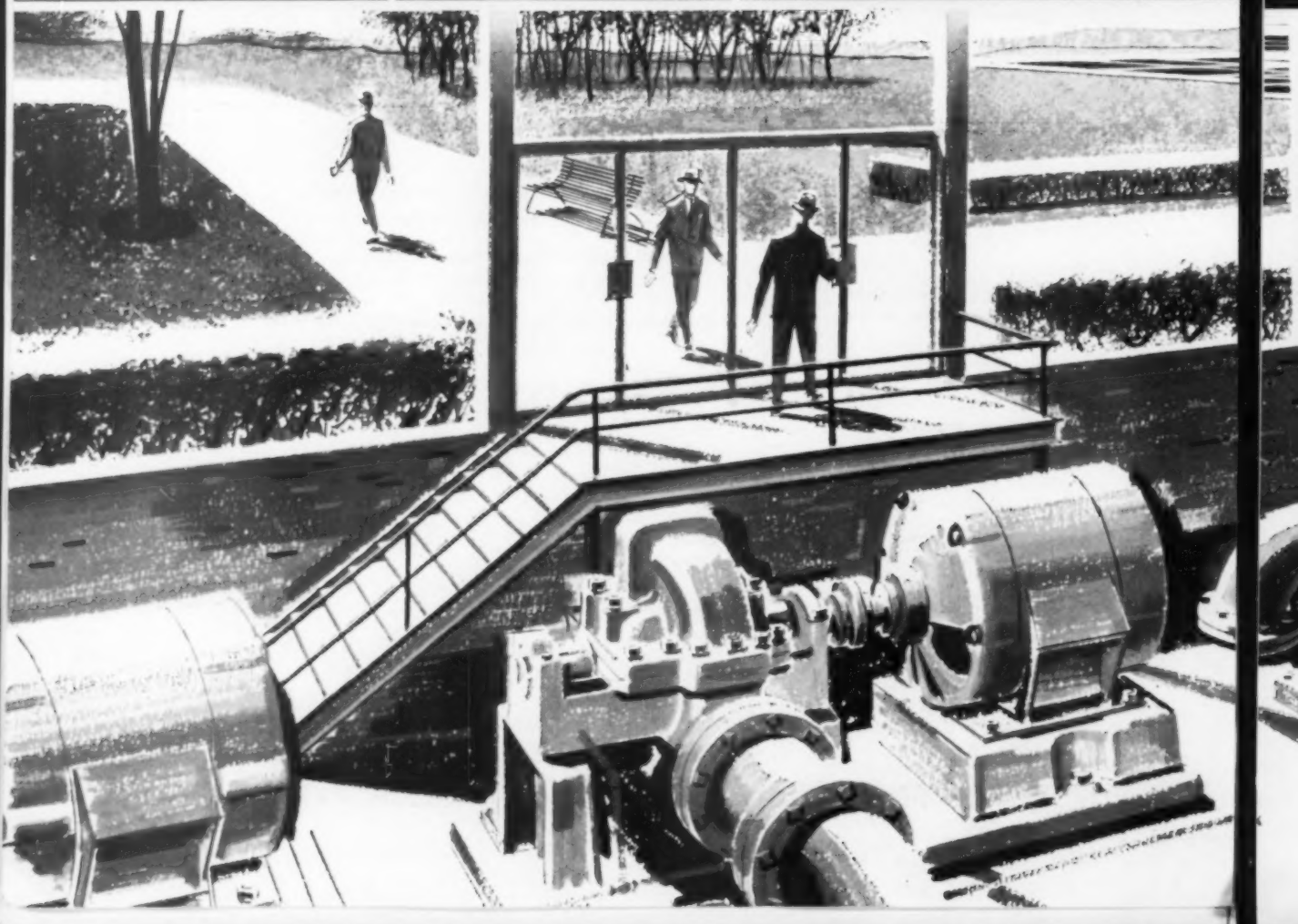
Westinghouse can help you get the most out of each shrinking dollar in a realistic way. First by providing everything you need electrically in one integrated line. It's simpler, surer, that way.

Further, by making available a specialist engineer on problems of power distribution for all kinds of proj-

1 SEWAGE SYSTEM SWITCHGEAR — CONTROL CENTER

2 CONTROL CENTER FOR SEWAGE PLANT

3 WATER WORKS SWITCHGEAR AND CONTROL CENTER



can be stretched electrically

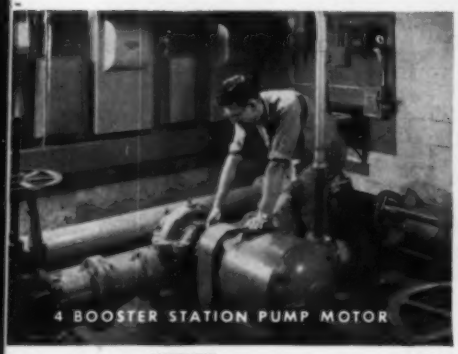
ects, power distribution systems, switchboards, motor applications, controls of every type, interior or area lighting . . . anything electrical.

There is a Westinghouse electrical construction engineer in your area who will head up a team of such specialists when you or your consultants want help on electrical specs that will stretch the budget. He's as close as your telephone. Call him.

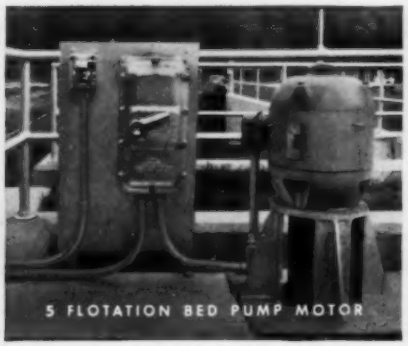
Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-93539

1. This close-coupled assembly of Westinghouse "drawout" switchgear and control center serves the modern sewage treatment plant at Bloomsburg, Pa. 2. Another control center at Bloomsburg. All units were factory-assembled and pre-wired. 3. Incoming power for the Houston, Texas, water purification plant is received in the 1000-kva, 4160/480-277-volt power center at right. Power control at left has 480-277-volt power section, 150-kva dry-type transformer and a 120/208-volt lighting section. 4. 40-hp Westinghouse motor, driving booster station pump. Safety switches and motor starters are shown on back wall. 5. Vertical-type circulating pump for flotation beds in a Cincinnati, Ohio, sewage plant driven by 100-hp Westinghouse Life-Line® motor. 6. Westinghouse motors drive priming pumps in Nadine (Pa.) pumping station.

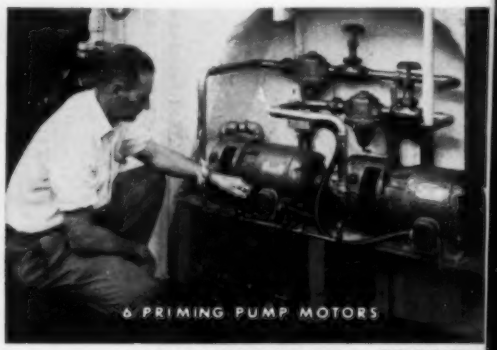
YOU CAN BE SURE...IF IT'S Westinghouse



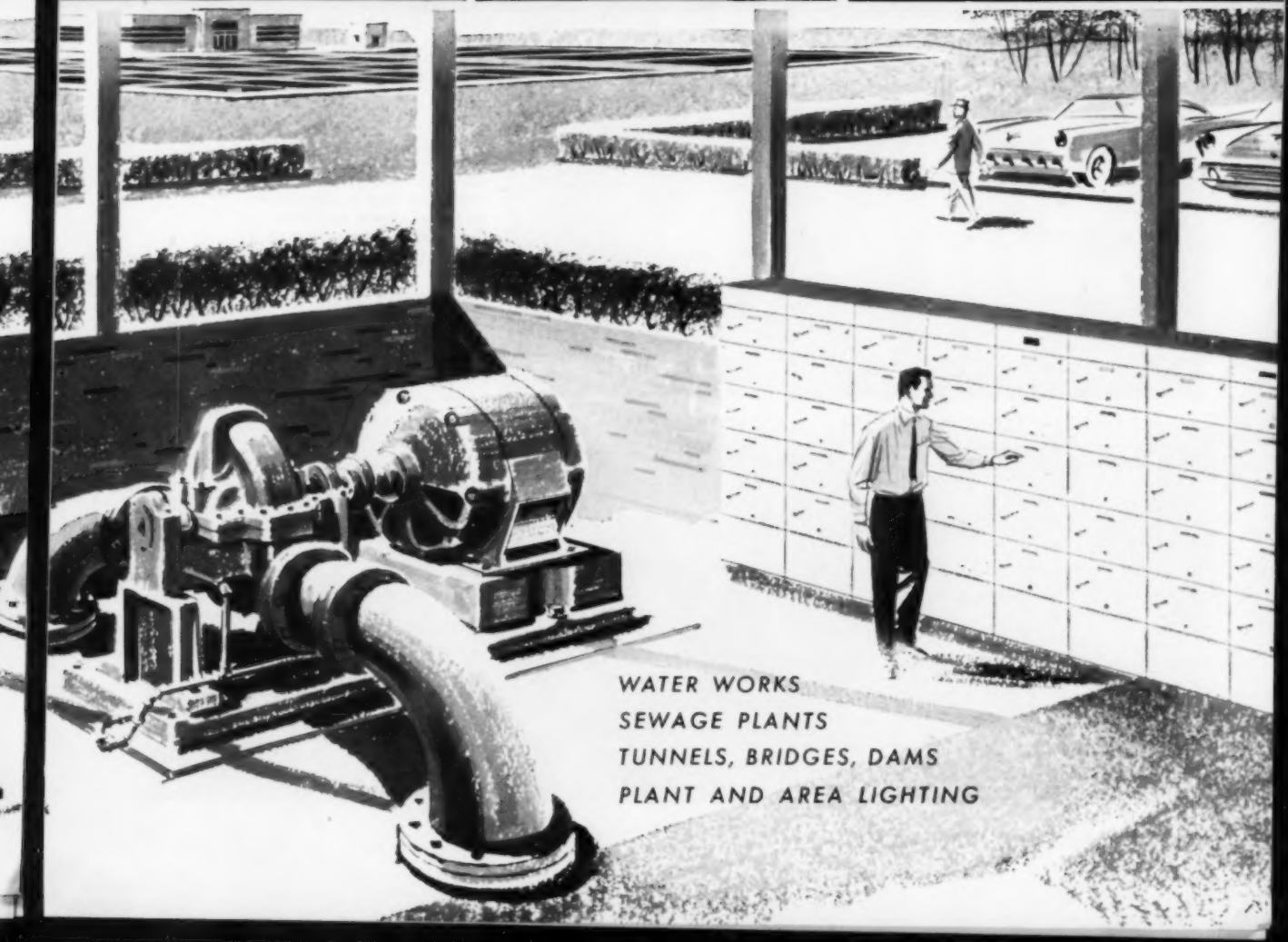
4 BOOSTER STATION PUMP MOTOR



5 FLOTATION BED PUMP MOTOR

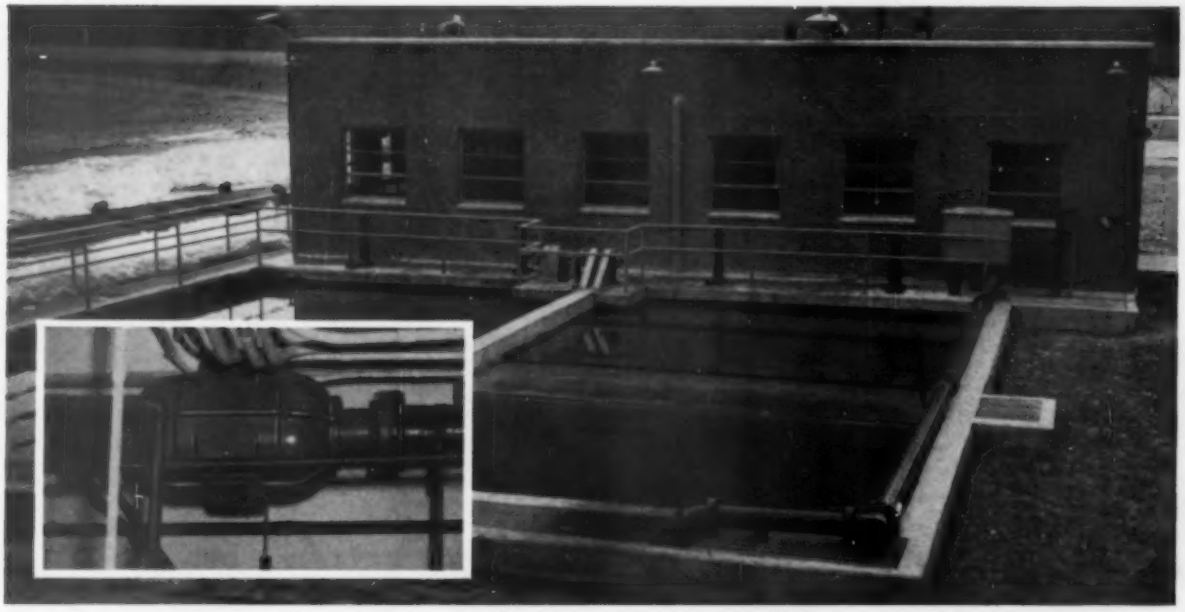


6 PRIMING PUMP MOTORS



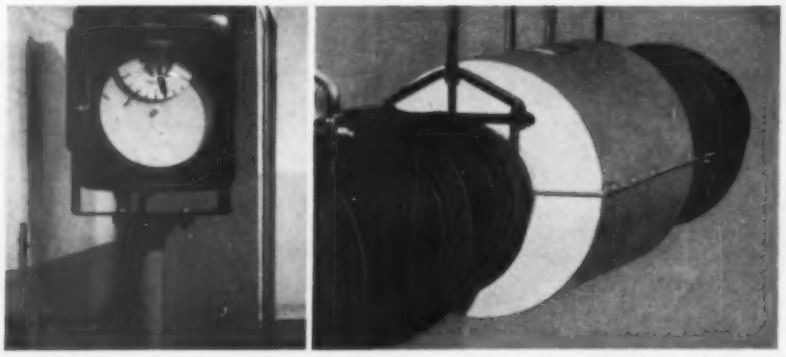
WATER WORKS
SEWAGE PLANTS
TUNNELS, BRIDGES, DAMS
PLANT AND AREA LIGHTING

Line Restriction



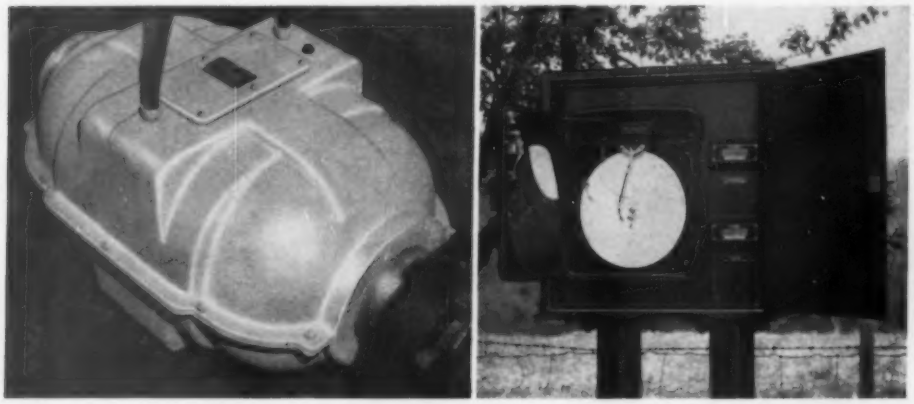
SIDNEY, OHIO

A Foxboro Magnetic Flow Meter was installed right in the return activated sludge line at Sidney's modern sewage plant. Supervisor reports it's been operating so smoothly that they haven't had to touch it.



FRAZER, MICHIGAN

12" Foxboro Magnetic Meter measures and totalizes raw sewage influent at Clinton Township treatment plant. Supervisor reports accuracy perfect — no variations — no maintenance since it was installed.



MEDFIELD, MASS.

Town of Medfield and nearby State Hospital have independent water supplies — use common storage facilities. Foxboro Magnetic Meter measures and records flow rates in both directions. Two integrators, next to recorder, keep separate running totals of both flow rates.

Problems Eliminated!

for these municipal utilities equipped with Foxboro Magnetic Flow Meters

Introduced three years ago, the Foxboro Magnetic Flow Meter has proved its superiority for measuring water, sewage, sludge and other treatment plant flows.

Foxboro Magnetic Meters are installed the same as a length of pipe. Measurement is linear and is transmitted by electric cable to centrally-located Dynalog* Flow Recorders. There are no line restrictions of any type. That means no added pressure drop . . . no seals, purges, meter runs, or straightening vanes.

Maintenance on the Magnetic Flow Meter is practically nil. There are no pressure taps to get plugged or frozen. No moving parts to foul.

Look over the installations on these pages. And for complete details write for Bulletin 20-14B. **The Foxboro Company, 8911 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off.

Other Progressive Communities Installing Foxboro Magnetic Flow Meters

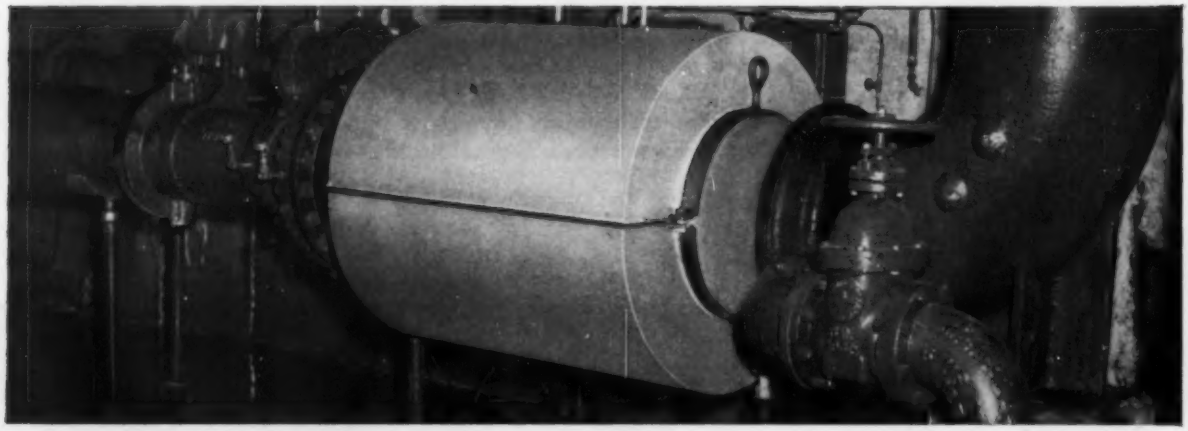
Benton Harbor, Michigan	— raw sewage
Hayward, Calif.	— water
Pittsburgh, Pa. (Allegheny County Sanitary Authority)	— raw sewage
Covington, Ohio	— return activated sludge
Warren Township, Michigan	— raw sewage and sludge
Bloomfield Township, Michigan	— water
Seattle, Washington (Lake City Sewage Plant)	— sludge
Milwaukee, Wisconsin	— sludge
Piqua, Ohio	— sludge
Arkansas City, Kansas	— sewage

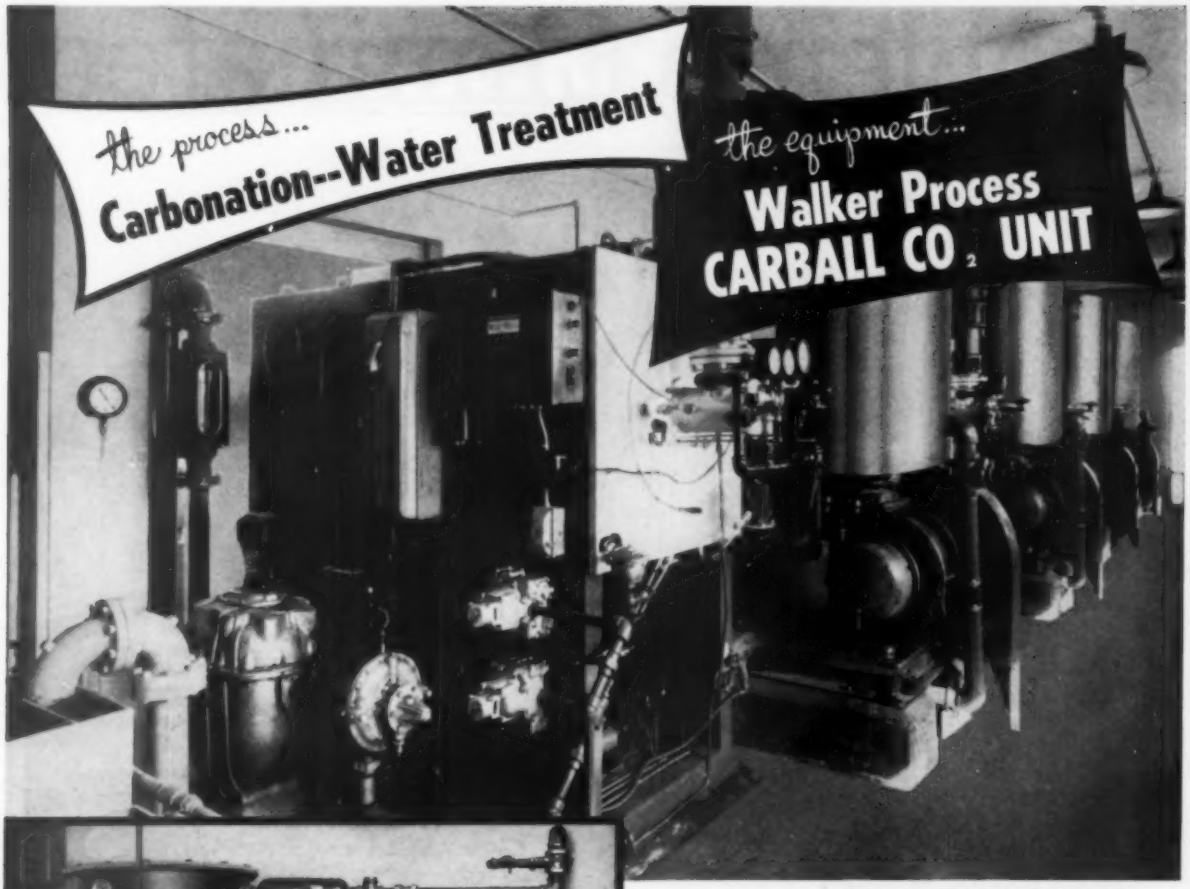
Meter sizes on these installations range from 3 inches to 6 feet.

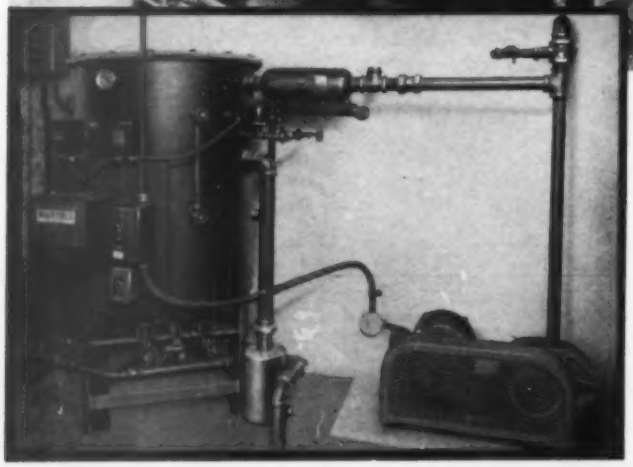
CHICAGO, ILLINOIS

This 20" Foxboro Magnetic Flow Meter was installed in the South District Filtration Plant in April, 1956. Because it has no line restrictions, plant officials knew the meter would add no more pressure drop than an equivalent length of pipe. Note how it was installed directly downstream from an elbow.

FOXBORO
REG. U.S. PAT. OFF.







Four size 4 Carballs at Kansas City, Mo. burn either gas or oil to produce max. of 40,000 lbs. CO_2/day. Size "O" unit at left produces 570 lbs. CO_2/day for Jefferson, Iowa Water Plant.

CARBALL
CO_2 UNIT

Walker Process now offers carbonation units for all lime softening plants from the very small to the largest. Sizes range from the new "OO" unit with minimum capacity of 55 lbs. CO_2/day to the No. 4 at maximum output of 10,000 lbs. CO_2/day.

Engineers can readily provide an entire carbonation system by simply specifying the appropriate size CARBALL in combination with Walker Process SPARJER diffusers . . . . . assuring

50% More CO_2
Clean, Tasteless Gas
100% Combustion
Unique Absorption Method
Economical Operation
Factory Tested Package System

Write for bulletins 7W83 - 7W85 and 7W88

WALKER PROCESS

WALKER PROCESS EQUIPMENT INC.
FACTORY • ENGINEERING OFFICES • LABORATORIES
AURORA, ILLINOIS

No matter how farsighted today's plans may be...

cities will grow old... in time

Famous "4 Corners," 1890— courtesy of Rochester, N. Y., Chamber of Commerce.

Your best insurance against obsolescence of your water system... specify EDDY Valves and Hydrants *throughout*

No matter how far into the future your city planning is projected, Eddy's record testifies that Eddy Valves and Hydrants are your best long term investment. Eddy Valve Company's more than 100 years of dependable operation means that, today, you can get replacement parts for any Eddy Valve or Hydrant ever installed. And our ability to continue to do so is your assurance against future obsolescence of your valves and hydrants.

EDDY Bronze-Mounted HYDRANTS open smoothly *with* the pressure and close without water hammer. One man can easily remove all operating mechanism for inspection and repair. Positive drip action automatically drains the standpipe, safeguarding against freeze-ups. Stem held in place below hydrant valve means that there is no water loss due to a bent stem.

EDDY Bronze-Mounted GATE VALVES offer simplicity of design, trouble-free operation and enduring service. From the engineering drawing boards through all stages of manufacture, they are step by step a truly "finished" product of workmanship. These factors, added to personal experience, tell why progressive water works men have relied on Eddy for generations.

Eddy Hydrants and Valves are available with hub, flange or mechanical joint connections to fit any existing or planned installation.

Send today for full data on the complete line of Eddy Valves and Hydrants. No obligation.

EDDY VALVE COMPANY

A Subsidiary of James B. Clow & Sons

WATERFORD, NEW YORK

LIKE ATOMIC POWER

AN ACTIVATED ENZYME

WRITE FOR PAMPHLET: "WHY ENZYMES?"

Sea-Cal M-200

triggers a chain reaction

The activity of the enzymes in Sea-Cal M-200 is the factor which makes this product successful for municipal and industrial sewage plant treatment.

WHILE ENZYMES ARE NOT "CURE-ALLS" there is irrefutable scientific data available, showing that many sewage disposal plants with problems in digestion, odor, matting, grease or B.O.D., have benefited immeasurably from the use of Sea-Cal M-200. Quality tested and certified by "referee" laboratories. Write today for detail information and name of distributor in your locality!

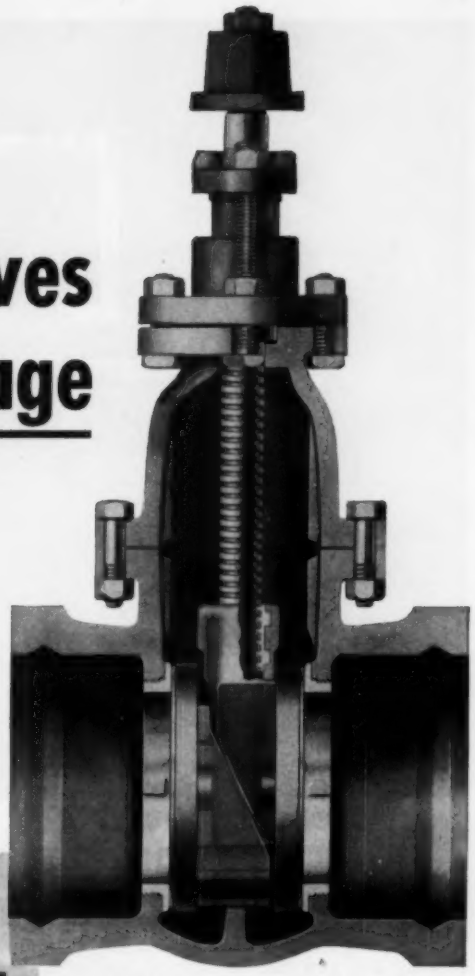
ACTIVATED CHEMICALS & PRODUCTS CO.

4610 HOLLYWOOD BLVD., LOS ANGELES 27, CALIFORNIA

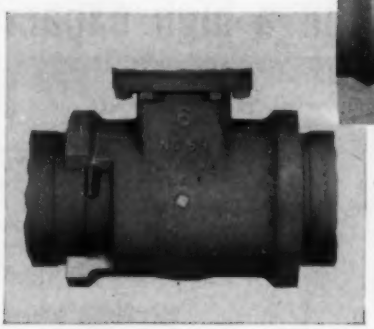
TRADE DARLING MARK

water works valves offer a 3-star advantage

★ *Outstanding performance*
★ *Long life*
★ *Complete selection*



Above: Cutaway of Darling Water Works Valve showing unique fully revolving double disc parallel seat principle, noted for long life, minimum maintenance and drop-tight closure.



Left: Mechanical Joint and Ring-Tite Joint . . . just two of the various valve ends available on Darling Valves.

DARLING'S topmost quality plus the Darling *fully revolving double disc parallel seat principle*, gives you an unbeatable combination.

The cutaway view shows Darling's simple gate arrangement with its plain no-pocket discs and wedges. These unique features, greatly lengthen disc and seat life, minimize maintenance and assure easy, tight closure and long life.

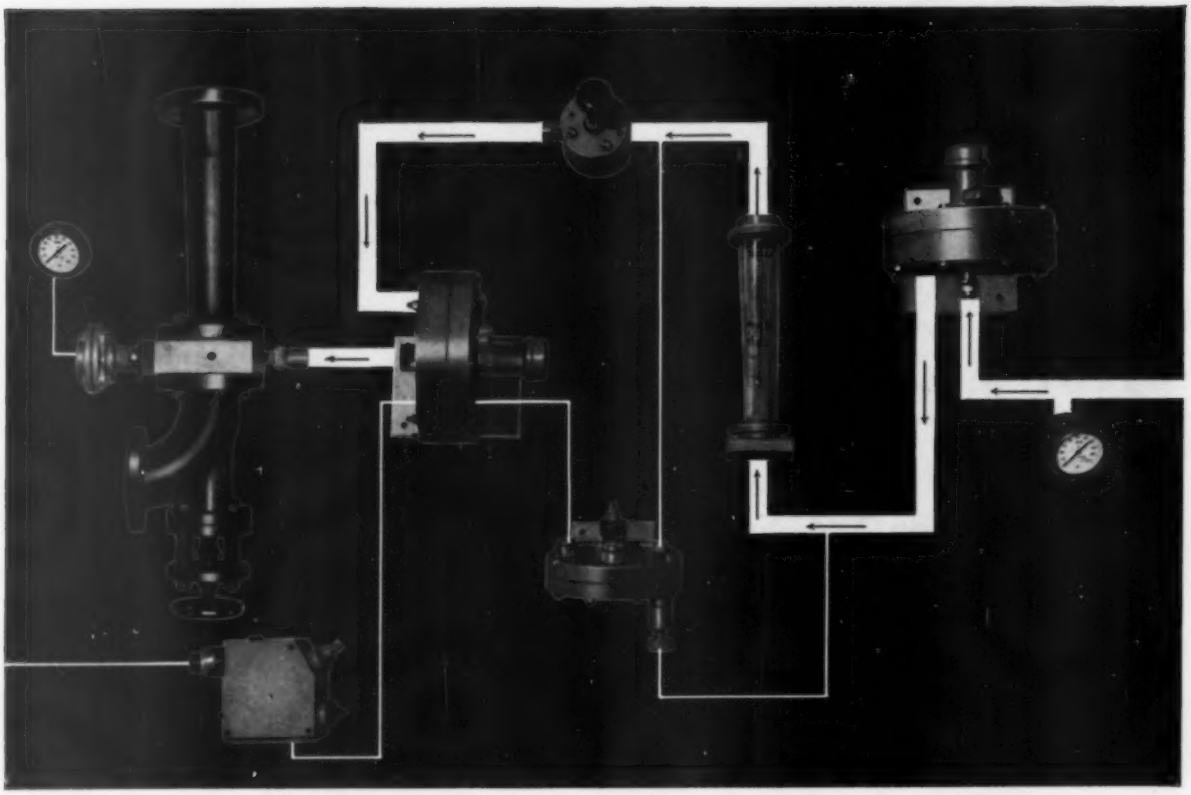
Conforming to A.W.W.A. specifications and available in sizes for your particular service, these valves are equipped with ends designed to meet your installation needs.

That's what we mean by a 3-star advantage. For detailed facts, send for Bulletin 5710.

DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.

Manufactured in Canada by The Canada Valve & Hydrant Co., Ltd., Brantford 7, Ont.



what to look for in a high capacity chlorinator

Flexibility . . . corrosion resistance . . . safety . . . low maintenance . . . proved performance . . . *whatever* you're looking for, you can be sure of finding it in Fischer & Porter's Model 1052A. The most imitated chlorinator ever introduced, Model 1052A remains unequalled in every major area of chlorinator performance and economy. Engineered from the ground up by chlorine control experts, it's an outstanding example of design from the *user* point of view.

flexibility matches the job

Model 1052A accommodates flow rates from 30 PPD to 8000 PPD by merely changing the chlorine flowmeter . . . a two minute job. And variable orifice ejector makes operation easy under varying conditions. Models are available for all types of manual, semi-automatic, and automatic operation with or without alarms.

corrosion-resistance for long trouble-free life

Recognized as a triumph in materials engineering, the Model 1052A is fabricated of inert materials throughout. Color is impregnated in the fiber glass plastic cabinet . . . never needs painting or coating. The only metals in contact with chlorine are silver and tantalum. The high pressure inlet tube is solid fine silver, and all other tubing is rigid corrosion-resistant plastic.

safe operation protects plant, personnel, public

System design protects against chlorine leakage, positive pressure conditions, excess vacuum, and flooding . . . eliminates need for hazardous water seals.

easily maintained for minimum down-time

Maintenance, like operation, requires no special skills. Any component can be removed for inspection with a screwdriver, wrench, and pliers in a few minutes. And engineering service is available from forty field offices across the country.

proved performance assures results

Every feature of the Model 1052A has proved itself in years of actual use. Every material used in construction has successfully withstood many years of severe chlorine service. But the best proofs of performance are the thousands of satisfied users of Fischer & Porter Chlorinators throughout the country.

Write now for complete details on the Model 1052A given in Catalog 70-15, available on request . . . and with it, we'll be happy to provide a list of installations. Visit any one of these and you'll see why so many users have found everything they were looking for in a Fischer & Porter Chlorinator. Write Fischer & Porter Company, 217 Fischer Road, Hatboro, Pa. In Canada, write Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario, Canada.

FP

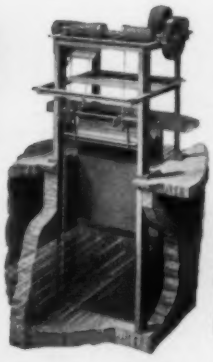
FISCHER & PORTER CO.

Complete Process Instrumentation

Get waste treatment off to a safe start...with LINK-BELT screens

...for removal of large solids

THRU-CLEAN SCREENS. Automatic, chain-operated rakes clean from downstream side, are designed to eliminate jamming by debris. Vertical mounting minimizes friction between rakes and bars.

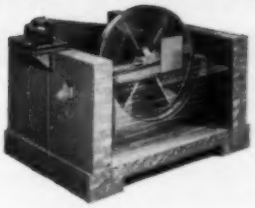


STRAIGHTLINE SCREENS. Automatic, cable-operated rake cleans from upstream side, assures clean, positive screenings removal. Easily accessible—no moving parts are mounted under water.

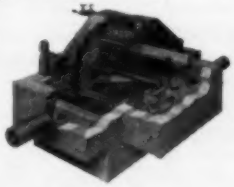
TRITOR SCREENS. Combined screen and grit chamber saves smaller plants the cost of separate units to remove large solids and detritus. Shredder for screenings can be provided, if desired.

...or small

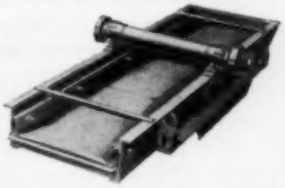
ROTARY DRUM SCREENS. Effectively remove fine solids from large volumes of water. These screens are best suited to installations where a fixed water level can be maintained.



LIQUID VIBRATING SCREENS. For thorough removal of fine solids from industrial liquids. High-energy vibration provides a relatively dry product with minimum blinding or clogging.



REVOLVING DISC SCREENS. For applications similar to rotary drum screens, but where volume is less. Simplified design contributes to ease and economy of installation. Very little maintenance required.



WHERE coarse or fine solids threaten to clog or damage subsequent equipment . . . where stream pollution must be prevented or valuable by-products can be recovered — efficient waste treatment begins with a Link-Belt screen. This broad line is your assurance of an impartial recommendation based on the specific nature of your waste. For full data, contact your nearest Link-Belt office or write for Book 2587.

LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1 To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.537

P.F.T.

NEW DEVELOPMENTS IN SEWAGE TREATMENT

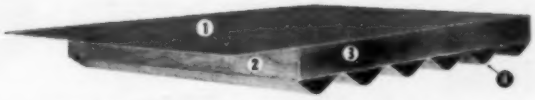
P.F.T. prefab aluminum roofing being installed at the Mill Creek Sewage Treatment Plant, Cincinnati, Ohio. Twelve 110-ft. P.F.T. Floating Covers are equipped with this new roofing. Consulting engineers: Havens and Emerson, Cleveland, Ohio.

Now! Lifelong decks for floating covers with new P.F.T. prefab metal roofing!

P.F.T. aluminum roofing is as permanent as the floating cover itself. Unlike conventional job-built decks, there is no wood or composition to rot. P.F.T. aluminum roofing requires little or no maintenance.

This new P.F.T. roofing consists of sturdy prefabricated panel sections; heavily embossed aluminum top sheets, and corrugated supporting bottom sheets. An inch-thick layer of Fiberglas insulation fills the space between. A liner of aluminum foil gives additional protection against heat loss. Helps maintain proper digester temperature control, and keeps heating costs down.

Shipped in easily handled sections, P.F.T. aluminum roofing installs quickly. Each piece is clearly marked for fast, accurate assembly at the plant site. Cut-outs and trim for manholes, sampling wells, hatch framing and other openings are shop fabricated. Aluminum ventilators are provided at the center, and over the sump wells at the rim. A 19"-wide service walkway also is furnished, extending from rim to center dome.



Section of P.F.T. roofing showing (1) aluminum top sheet, (2) inch-thick Fiberglas insulation, (3) aluminum reinforcing channels, (4) corrugated supporting ribs.

P.F.T. prefabricated aluminum roofing is available for both new and existing floating covers. For long range economy, it is the most permanent, best insulated roofing available. For complete details, write today for newly published, illustrated, 12-page Technical Bulletin No. 333.

waste treatment equipment exclusively since 1893

P.F.T.

PACIFIC FLUSH TANK CO.
4241 Ravenswood Avenue
Chicago 13, Illinois

PORT CHESTER, N. Y. • SAN MATEO, CALIF. • CHARLOTTE, N. C. • JACKSONVILLE • DENVER

is the big extra you get with Honeywell Instrumentation

Whether you buy a replacement part, a single instrument or a complete control system from Honeywell, you get service that no other instrument manufacturer can match for completeness.

It is service that begins when you first decide you need instruments, and continues long after they're installed. It includes:

- Preliminary engineering, even before specifications are written.
- Application engineering for installation and startup.
- Service engineering help from your nearby Honeywell branch, which has a completely staffed installation department.
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- Ready availability of parts and accessories from branch offices and Honeywell's Central Supply Depot.
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Your nearby Honeywell field engineer will be glad to discuss this service in light of your particular needs. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

H HONEYWELL First in Controls

Water Flavor Improved

Flavor is detected through a combination of the senses of taste and smell. Therefore, the problem of odor plays a very large part in the flavor of foods. Water is actually a food in that it is essential to human existence. From the viewpoint of health, water is important, since doctors recommend an intake of 8 glasses or more per day. Certainly such an intake would be greatly discouraged unless the water supply is wholesome and palatable.

The water odor problem has been solved with Aqua Nuchar Activated Carbon. Baylis* states: "All tastes and odors likely to be present in a water supply can be removed with activated carbon. . . . We find a few statements in the literature on water treatment that the taste or odor was not removed by the addition of carbon, but almost invariably the reason was that not enough carbon was used."

If you are bothered by odors in your water supply, we will be happy to work in your plant and demonstrate how to render the water palatable. This service is rendered without cost or obligation on your part.

* John R. Baylis. Elimination of Taste and Odor in Water. McGraw-Hill Book Company

GOOD CARBON · GOOD WATER · GOOD WILL

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you get all this with

AMPLE DEFLECTION

Photo shows how easily Clow Bell-Tite joints handle casual curves or normal grades without fittings.

TIGHT JOINTS

Full length, restrained joint, bursting tests prove Bell-Tite joint, even fully deflected, is stronger than the pipe.

FAST INSTALLATION

Above, Clow 8" Bell-Tite pipe being installed at the rate of 25 joints per hour. No bell holes are required.

SIMPLE ASSEMBLY

Wipe clean, lubricate, and push spigot into bell. When painted yellow stripe disappears, joint is bottle-tight!

CLOW BELL-TITE JOINT*

cast iron pipe

Here's the new time-saving, labor-saving, money-saving way to lay watermain. A single gasket, rubber seal joint that requires no bolts or follower glands to make a tight, dependable joint. Listed by the Underwriters' Laboratories, Inc., for water working pressures up to 350 psi, the pipe itself meets all applicable provisions of AWWA, ASA, and Federal Specifications. Complete details gladly rushed to you on request.

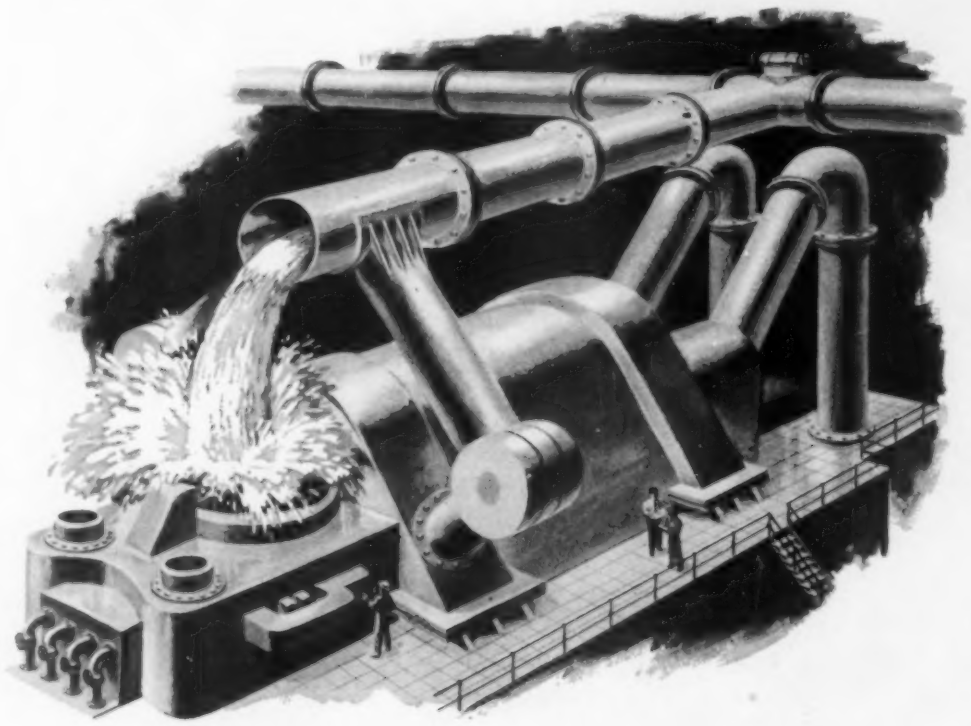
*Patent applied for.

SINCE 1878

JAMES B. CLOW & SONS, Inc.

201-299 North Talman Avenue, Chicago 80, Illinois

Subsidiaries:
Eddy Valve Company, Waterford, New York
Iowa Valve Company, Oskaloosa, Iowa



can't quench his thirst!

Over 70 billion gallons daily . . . industry's need for water.

And, like Oliver Twist, industry constantly calls for "More." 18 barrels of water to make one of oil. 365,000 gallons to produce a ton of rayon. 250 tons for one of wood pulp. And every ton of coal we burn for steam and power requires another 600 to a thousand tons of water!

Not hard to understand why water officials are worried about our supply. Here's what you can do to protect it.

1. Encourage future water planning.
2. Support realistic water rates and water supply bond issues.
3. Conserve water where you can.

America is no longer rich . . . in water.

PROOF POSITIVE
CAST IRON PIPE SAVES
YOU TAX DOLLARS

Still in service this cast iron main laid in Utica, N. Y. in 1849 is still piping water. This is typical of many century old cast iron water and gas mains now serving throughout America.

Small wonder that where long life, dependability and economy are "musts," water officials prefer cast iron pipe . . . No. 1 Tax Saver!

CAST IRON PIPE
RESEARCH ASSOCIATION — SUITE 3440, PRUDENTIAL PLAZA, CHICAGO 1, ILL.

MODERNIZED cast iron

YOUR PROBLEM GROWS WITH YOUR COMMUNITY

As people and industry move into a community, water problems multiply.

Cast Iron Pipe Research Association advertisements*... like the one at left... not only tell what those problems are, they suggest a course of public action.

Action that will help *you* by enlisting greater public sympathy and support for *your* water program.

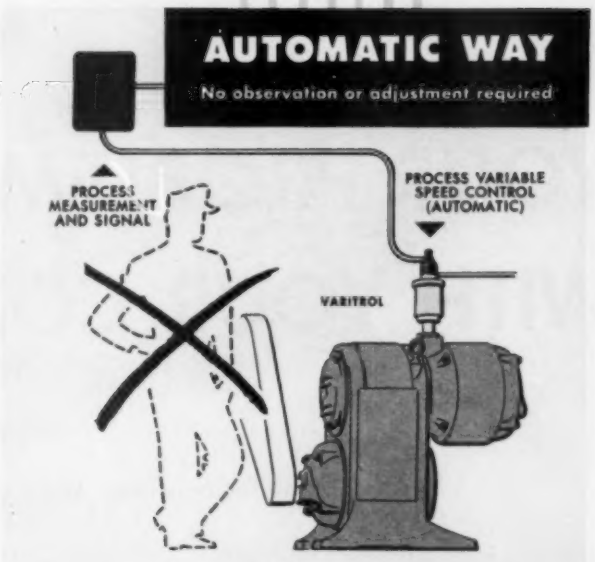
CAST IRON

Cast Iron Pipe Research Association, Thos. F. Wolfe,
Managing Director, Suite 3440, Prudential Plaza, Chicago 1, Ill.

**Appearing in:* Saturday Evening Post,
U. S. News & World Report, Nation's Business.

pipe FOR MODERN WATER WORKS

HOW VARITROL AUTOMATIC SPEED CONTROL saves Manpower



Human Error is Eliminated with U. S. VARIDRIVE MOTORS WITH VARITROL

Now, by controlling speed with Varitrol as a component of the U.S. Varidrive motor, speeds can be *automatically* changed in response to a signal *without* human attention. Varitrol pneumatic control regulates the speed of Varidrives in response to a signal from such variables as temperature, humidity, pressure, speed, liquid level, weight and tension. Varitrol automatic control of Varidrives offers an opportunity for improved quality of product, greater uniformity and more efficiency in plant flow handling. A profusely illustrated multi-color booklet explaining in detail the construction and operation of Varitrol automatic control is available. Write today for your copy.

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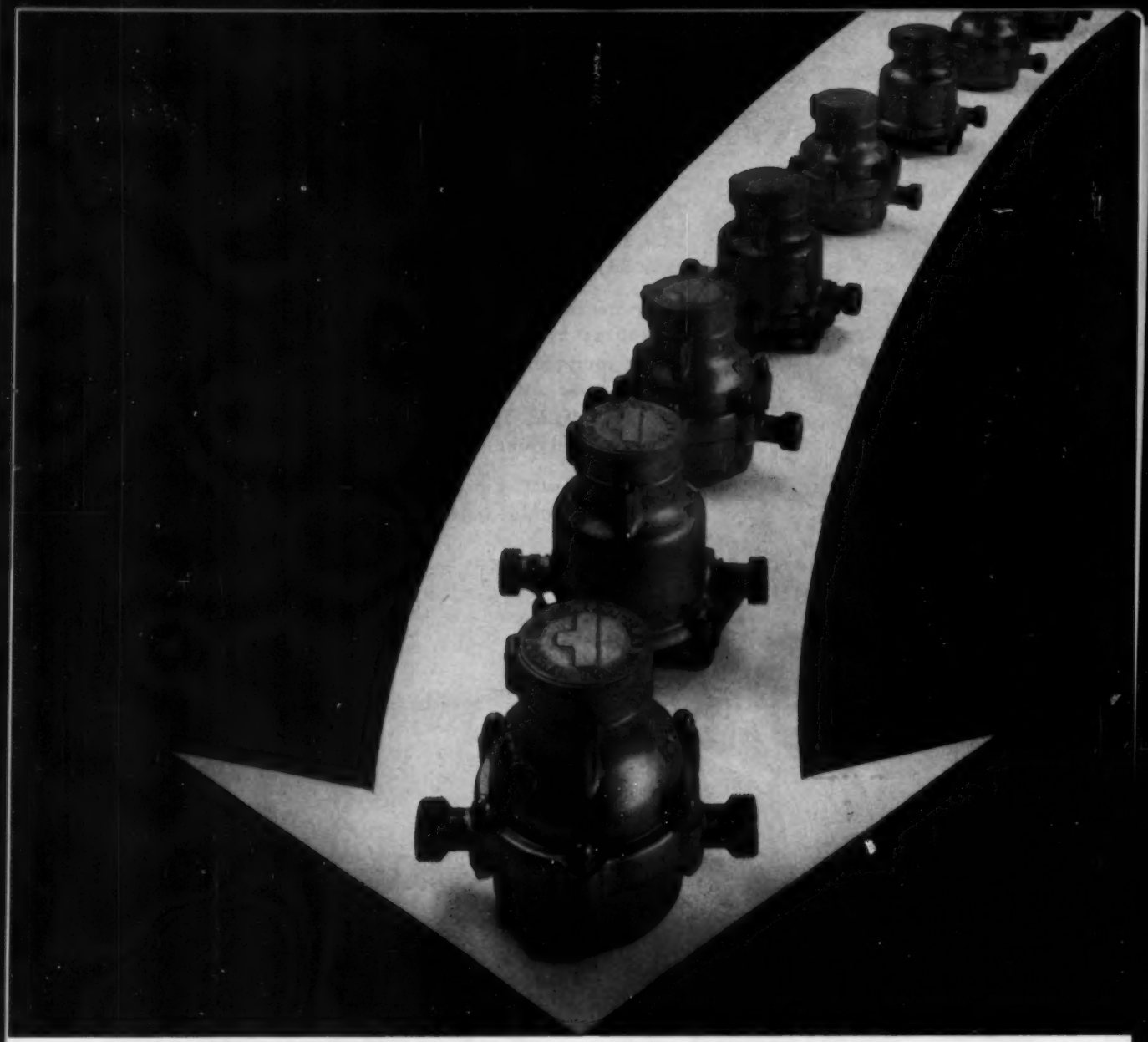
MAIL COUPON NOW



HERSEY

WATER METERS

Are Your Best Buy

for

Accurate Registration - Long Life - Low Maintenance Cost

HERSEY MANUFACTURING COMPANY

DEDHAM, MASS.

BRANCH OFFICES: NEW YORK — PORTLAND, ORE. — PHILADELPHIA — ATLANTA — DALLAS — CHICAGO
SAN FRANCISCO — LOS ANGELES

why work like

No need to when you lay Tyton Joint® pipe. This quick and easy-to-assemble pipe goes in so smoothly it's a pleasure to work with.

Only one accessory needed—a simple rubber gasket that fits in the receiving pipe bell and is compressed by the entering spigot to permanently seal the joint. No bell holes. No weather worries. Tyton Joint can be laid in rain or wet trench.

A word of warning, however: make sure your trenching machine gets an early start or

U.S. cast iron PIPE FOR WATER, SEWERAGE AND

a dog?

your laying crew—even an inexperienced one—will catch up fast.

Like all the facts on this new, time-and-money-saving pipe? Call or write today.

U. S. PIPE AND FOUNDRY COMPANY
General Office: Birmingham 2, Alabama

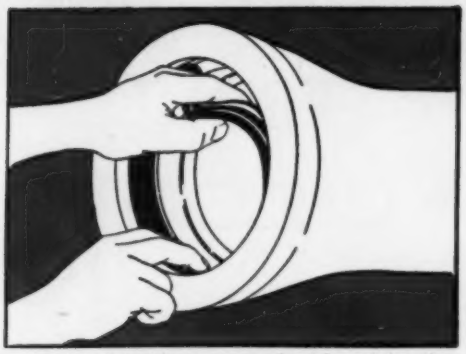
A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE

"WE NEED A COUPLE MORE DAWGS, GRAN'MAW...WE'RE LAYIN' THE TYTON FASTER'N THEY KIN DIG"

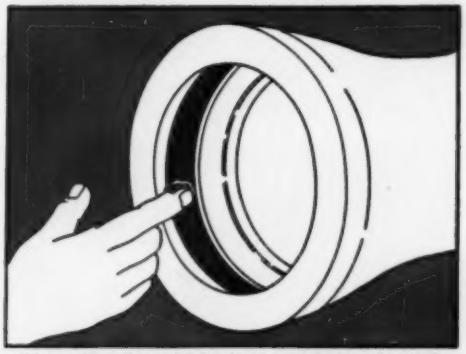
INDUSTRIAL SERVICE CAST IRON

U. S. TYTON JOINT

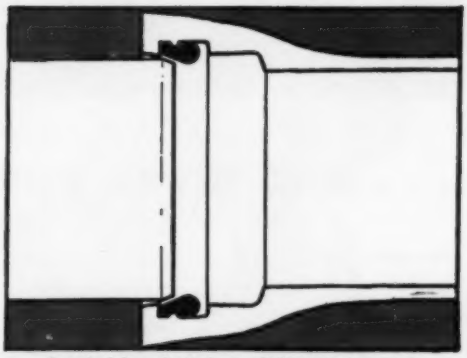
ONLY FOUR SIMPLE ACTIONS



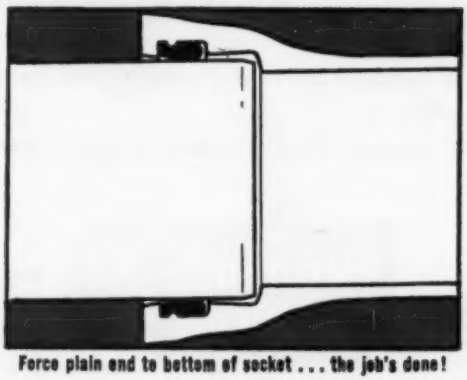
Insert gasket with groove over bead in gasket seat



Wipe a film of special lubricant over inside of gasket



Insert plain end of pipe until it contacts gasket



Force plain end to bottom of socket . . . the job's done!

Pennsalt
FERRIC
CHLORIDE

saves
sedimentation
time . . .

Filter manufactured by Komline-Sanderson Engineering Corp.

. . . and gives your filters a new lease on life!

Sewage disposal operations are materially simplified and improved in performance when Pennsalt's Ferric Chloride goes to work. Treating fresh or digested sludge with $FeCl_3$ permits immediate filtration without the usual losses in sedimentation time. It effectively meets any changes in waste composition, does a thorough job of precipitation, and increases filter efficiency.

Pennsalt Ferric Chloride multiplies your vacuum-filter capacities through superior coagulation. This rapid flocculating action produces drier, denser cake, giving you higher output per square foot of filter area.

Anhydrous $FeCl_3$ is available in non-returnable steel drums of 135 and 350 lbs.; liquid $FeCl_3$ is shipped in tank cars. Contact your nearest Pennsalt sales office for full technical information on Ferric Chloride and other chemicals for water purification and sewage: Chlorine, Alum, Perchloron®, and Ammonia.

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NO FOGGED REGISTERS

NO STUFFING BOX

NO LEAKS OR BINDS

ROCKWELL

SEALED REGISTER WATER METER

with Powerful Magnetic Drive

You can run this meter under water if you want to . . . subject it to the most severe abrasive or corrosive conditions. No matter, the register will stay clean, dry and protected because it's *hermetically sealed*. Condensation, dirt, surface water and atmosphere are permanently excluded. This register *cannot fog*, so can always be read. And the sealed assembly is *fully guaranteed* for a period of five years.

There's no stuffing box to leak or bind. A powerful magnetic coupling between the measuring chamber and sealed register *positively* transmits motion without mechanical linkage or seal. This friction-free construction improves meter accuracy especially on low flows.

What about maintenance? With only two moving parts running in water (the piston and piston roller) it's the *least vulnerable* meter ever—the easiest, quickest and most economical to repair.

Get full facts now. Write for bulletin. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ALOXITE® underdrains solve filter problems for growing Barranquilla

Water consumption in Barranquilla, Colombia, jumped from 8.04 to 19.10 MGD between 1935 and 1950. This created quite a problem for the city's Empress Publicas Municipales. They tackled it by giving experts a free hand to investigate every method and material known in order to give Barranquilla the best water supply system obtainable.

Today Barranquilla boasts a brand new 12-MGD water filtration plant. And each of its three 4-MGD filter units is equipped with ALOXITE® aluminum oxide porous plate underdrains. ALOXITE underdrains were chosen because they have proved they can handle growing loads like those at Barranquilla with freedom from mudballs and with minimum loss of head. Complete backwashing is accomplished without upset beds.

All work on this outstanding installation was under the supervision of Dr. Samuel L. Hollopeter and Dr. Efraim Pereira, Director General and Chief Engineer, respectively, of the Empress Publicas Municipales.

Answer your questions about porous media with Carborundum's 56 page booklet, "Porous Media." It's yours for the asking. Just write to:

CARBORUNDUM

Registered Trade Mark

Dept. X117

The Carborundum Company, Perth Amboy, N. J.

add a valve...

anywhere...

with MUELLER INSERTING VALVES and equipment

H-800 Inserting Valves
For 4", 6" or 8" mains. Working pressure to 125 p.s.i. max. Equipment required: Drilling machine, H-810 inserting equipment.

You can install needed control points in the line – without a shutdown – with Mueller Inserting Valves. Inserting Valves are added to line under pressure without loss of fluid or customer inconvenience.

Valve sleeve is attached to the main... the line drilled with a Mueller "C-C" or "C-1" Drilling Machine ...valve body is inserted and fastened...and line is then equipped for precise flow control. The Mueller Inserting Valve is identical to job-proven Mueller Gate Valves with four-point wedging mechanism.

Use Mueller Inserting Valves and Equipment to add the valves you need.

Your Mueller Representative has further information. Call on him or write direct.

MUELLER CO. 100th YEAR QUALITY SERVING the Water and Gas Industries

MUELLER CO.
DECATUR, ILL.
Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

Since 1857

Sewage SLUDGE

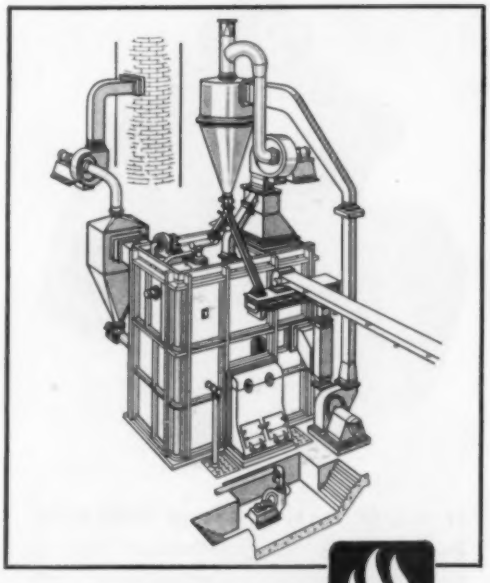
BURN IT!
SELL IT!

You can do both with the C-E Raymond System

For versatility alone, you can't beat the *C-E Raymond System of Flash Drying and Incineration!* With it, you can incinerate sewage sludge to a sterile ash...or flash-dry it to a fertilizer and soil conditioner that is readily marketed. Either operation can be performed alone, or combined in any proportion.

In either case, high-temperature deodorization of stack gases is available.

Whether you wish to incinerate or dry—look to the C-E Raymond System for the effective end to your sludge disposal problems. For specific recommendations for your community, get in touch with a C-E specialist at the office nearest you. He will be happy to work with you and your consultant.



C-E

B-930

COMBUSTION ENGINEERING

RAYMOND DIVISION

1315 North Branch Street, Chicago 22, Illinois

Eastern Office: 200 Madison Avenue, N. Y. 16, N. Y. *Western Office:* 510 West Sixth Street, Los Angeles 14, Calif.

Canada: Combustion Engineering-Superheater Ltd.

ALSO FLASH DRYING AND INCINERATION SYSTEMS FOR INDUSTRIAL WASTE DISPOSAL

FOR THE BEST IN *Water Meters*

go ALL AMERICAN

AMERICAN METERS

Build Water Revenue

Here are some of the design features of American Meters that help you build Water Revenue:

A. A thick reinforced measuring disc is used to reduce slippage between the disc and measuring chamber wall. With this construction the clearance can be sufficient to prevent damage from grit or scale and still make a more efficient seal than is possible with a thin disc at the same clearance.

B. The seal between disc and measuring chamber is maintained in any position.

C. Absence of a thrust roller reduces friction and avoids noise.

D. Precision machining of all parts reduces friction and wear for continued measuring accuracy.

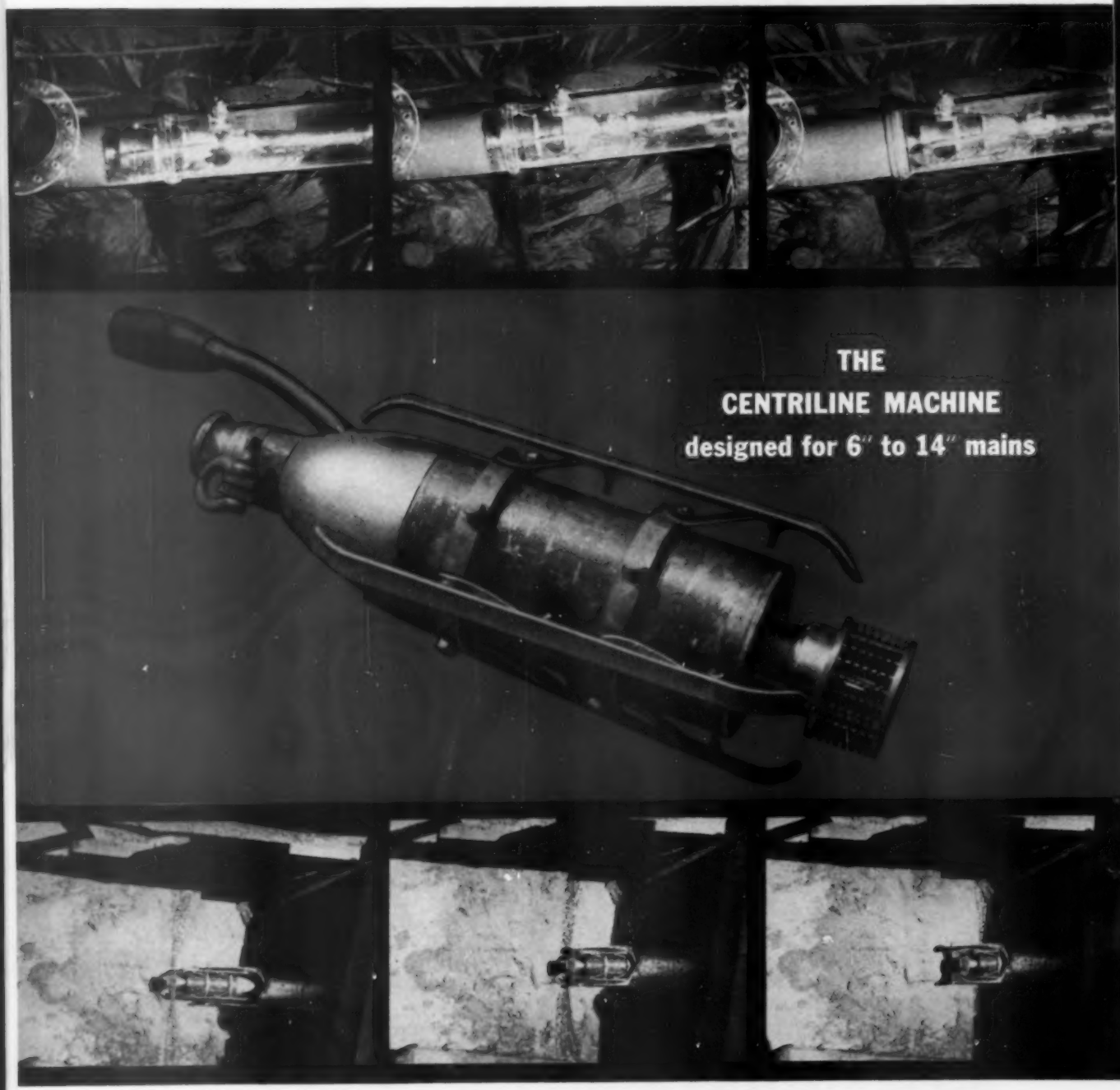
If you want full revenue from the water you supply, "go all AMERICAN."

BUFFALO METER CO.

2909 MAIN STREET BUFFALO 14, NEW YORK

Announcing the most revolutionary development

NOW! THE CENTRILINE PROCESS

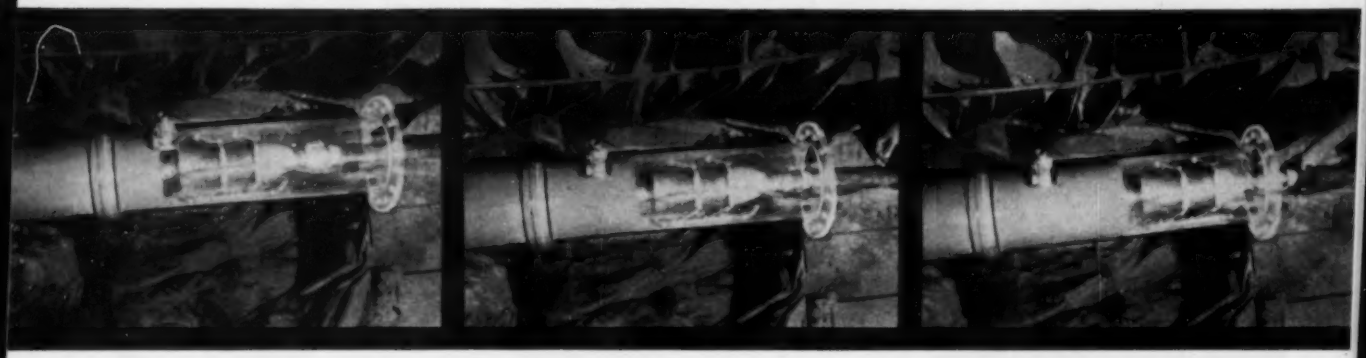


STRIP PHOTO • TOP: *Cross section view, in special transparent pipe, showing new small size Centriline machine in action being pulled through the pipe from left to right. Note the uniformity of the cement-mortar lining.*

STRIP PHOTO • BOTTOM: *View of machine at work in special cut away pipe illustrating centrifugal application of the cement-mortar.*

in the water works field in the past 15 years!

is also available for 6″ to 14″ mains



NOW, for the first time, your city's small but important transmission and distribution lines, including those used for fire protection, can regain their original flow capacity and pressure through the famous Centriline Process. A smaller version of the Centriline machine has been developed for use in 6″ to 14″ mains.

Here is how Centriline rehabilitates water systems' distribution grids. First, the pipes are cleaned to remove all tubercules, scale and loose materials resulting from corrosion. The Centriline machine is placed in the pipe and mortar is forced into a rapidly revolving head which applies a uniform coating on the pipe wall by centrifugal force. The thickness of the lining can be regulated by careful control of the machine. All of this is accomplished with a minimum of interruption to surface traffic, since the pipes are lined in place!

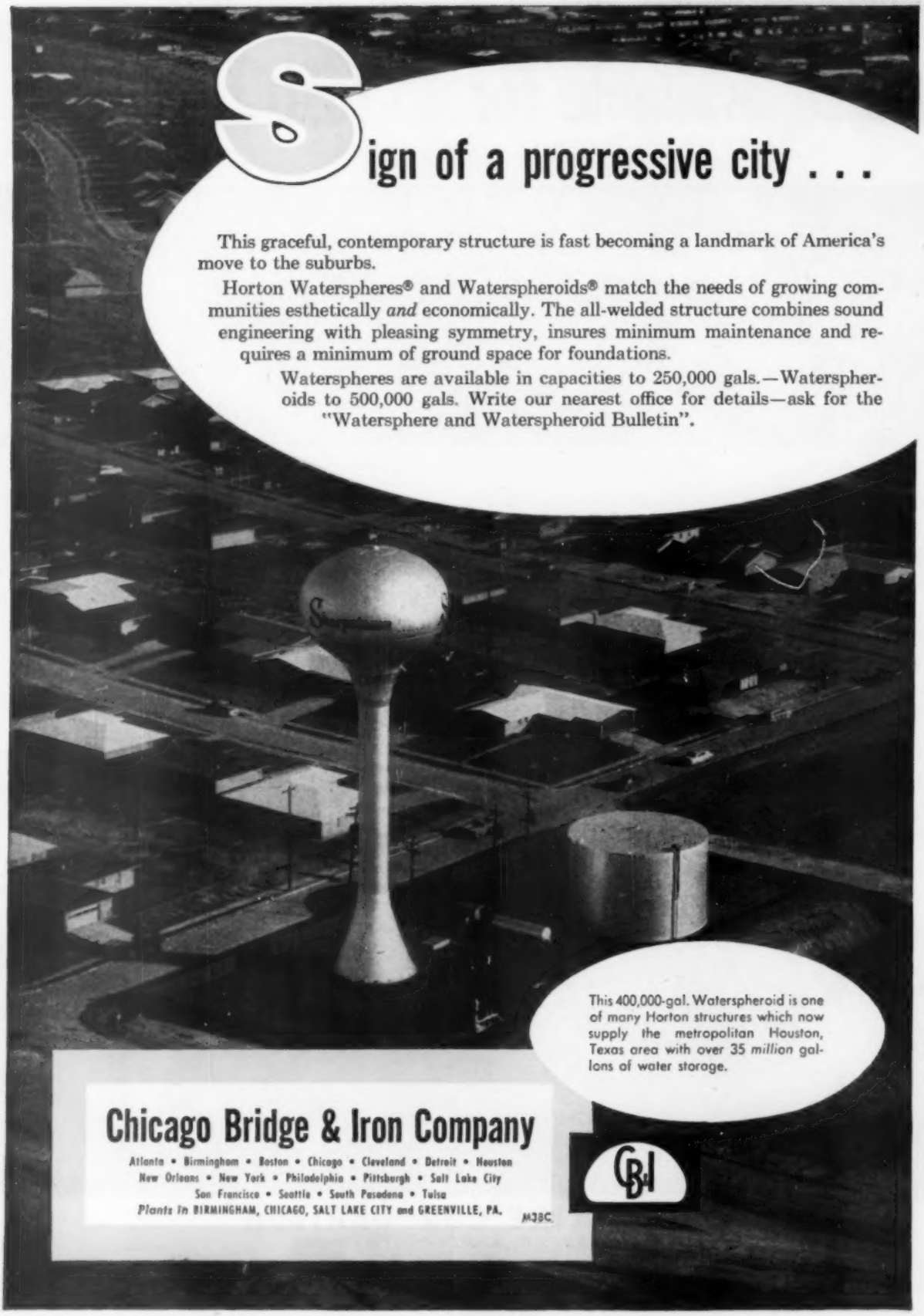
The advantages of using the new, small diameter Centriline machine in your mains are numerous. The new machine has a design feature which eliminates most excavations at valves, laterals and corporation cocks. The cost is lower than ever before. In addition, Centrilining permanently prevents future tuberculation, corrosion or leakage . . . reduces maintenance and pumping costs . . . raises distribution pressures and efficiency and extends the life of steel or cast iron pipe indefinitely. Send today for your free copy of our illustrated booklet which fully describes how Centriline can help you salvage worn out water lines of every size.

CENTRILINE CORPORATION

A Subsidiary of Raymond Concrete Pile Company

140 Cedar Street
New York 6, N.Y.
WOrth 2-1429

Branch Offices in Principal Cities of the United States, Canada and Latin America



Sign of a progressive city . . .

This graceful, contemporary structure is fast becoming a landmark of America's move to the suburbs.

Horton Waterspheres® and Waterspheroids® match the needs of growing communities esthetically *and* economically. The all-welded structure combines sound engineering with pleasing symmetry, insures minimum maintenance and requires a minimum of ground space for foundations.

Waterspheres are available in capacities to 250,000 gals.—Waterspheroids to 500,000 gals. Write our nearest office for details—ask for the "Watersphere and Waterspheroid Bulletin".

This 400,000-gal. Waterspheroid is one of many Horton structures which now supply the metropolitan Houston, Texas area with over 35 *million* gallons of water storage.

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
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Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.

M38C

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Forests Protected...

but how about our most precious possession...water?

You'll save water—increase the system income—with Badger Meters

Forest conservation costs millions — and it's worth it. But the millions of *wasted gallons* of increasingly scarce water *could* cost the future of entire communities. Yet one basic step—replacing flat rates with Badger Meters — sharply reduces waste. Water revenue rises. And because they are Badger Meters, peak meter performance is assured for years.

Badger Meters have an unsurpassed record for low maintenance cost: ruggedly built of finest copper alloy. Control adjustment is simple. Working parts are few and standardized for easy, inexpensive replacement if ever needed.

By thus installing the finest meters available—Badger Meters—you put the department on an efficient, good-business basis, while saving vital water supplies through fair-share, fair-pay metering. Act now! Write for literature or to arrange a helpful consultation with a Badger Meter representative.

Outstanding disc, turbine and compound meters—⅝" through 12" —precision-engineered for lasting service.

Water is vital

Badger Meters have conserved it better for over 50 years.

Badger Water Meters

BADGER METER MFG. CO. — 2371 North 30th Street
Milwaukee 45, Wisconsin • *OFFICES IN PRINCIPAL CITIES*

SMS-Rotovalves On Sewage Pump Discharge

GIVE ACCURATE THROTTLING

At Philadelphia's Southeast and Central Schuylkill Pumping Stations, twelve SMS-Rotovalves with electric operators are installed at the discharge ends of vertical centrifugal pumps. These 30-inch Rotovalves were chosen for their reliability of operation and ability to throttle pump discharge accurately.

Their full-line opening cuts pressure loss to lower pumping costs. Self-purging, monel-to-monel seats are out of the stream, and less subject to wear. Rotovalves give quick, easy throttling operation. Bronze trunnions eliminate friction as the plug first lifts, then turns, finally reseats in the desired position. For emergency closure, maximum initial shut-off eliminates sufficient line surge shock to prevent damage to pump parts.

You can obtain full information on SMS-Rotovalves, as well as the complete line of Ball Valves and R-S Butterfly Valves, by contacting our nearest representative. Or, write to S. Morgan Smith Company, York, Penna.

◀*Overall view shows dry well and discharge risers. Close-up (lower photo) shows a 30-inch Rotovalve equipped with electric motor-driven operators.*

S. MORGAN SMITH

HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

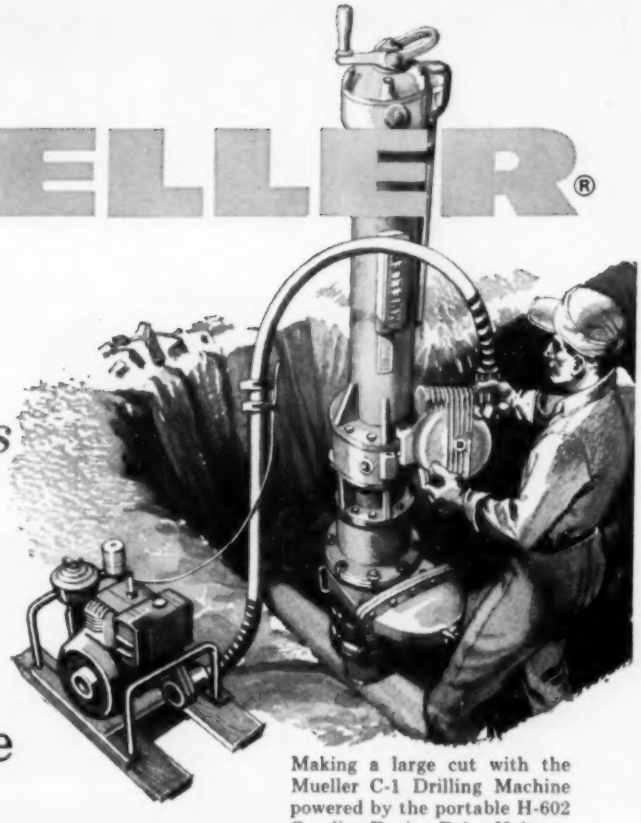
6

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

MUELLER®

save time on cuts 2" through 12"

...with the power-driven C-1 Drilling Machine

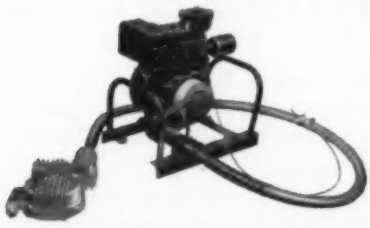


Making a large cut with the Mueller C-1 Drilling Machine powered by the portable H-602 Gasoline Engine Drive Unit.

The Mueller CC Drilling Machine offers basically the same features as the C-1, but is hand-operated.

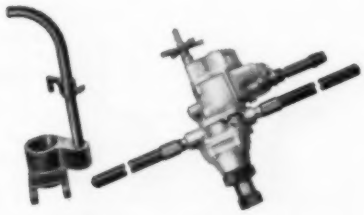
Install inserting valves, connect branch mains and make other cuts through cast iron, steel and asbestos-cement pipe with the power-driven Mueller C-1 Drilling Machine.

Automatic or manual feed gives the operator positive control over the complete 25" boring bar travel. A feed indicator shows the actual depth of the cut at any time during the drilling operation. Cuts can be made under pressures to 500 p.s.i. at 100° F. or under temperatures to 500° F. at 250 p.s.i.



H-602 Gasoline Engine Drive Unit

Both the H-600 Air Motor and the H-602 Gasoline Engine Drive Units are specifically matched to the C-1 Drilling Machine for maximum performance. The air motor unit will advance the boring bar 1" in about 8 minutes. The gasoline engine unit is a trifle slower but is more powerful and gives more positive results when making large cuts through steel pipe.



H-600 Air Motor Drive Unit

Compare the many advantages of the power-driven Mueller C-1 Drilling Machine with your present method of making cuts. Ask your Mueller Representative for complete information and costs.

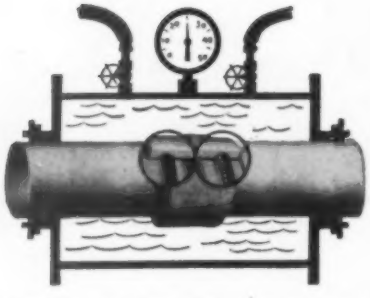
Since 1857

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles; In Canada: Mueller, Limited, Sarnia, Ontario

THE MODERN PIPE JOINS FAST, STAYS TIGHT

"K&M" ASBESTOS-CEMENT PIPE and exclusive FLUID-TITE Coupling



Infiltration of external fluids and entrance of roots are eliminated by "K&M" FLUID-TITE Coupling installed with "K&M" Asbestos-Cement Sewer Pipe. Here, external water under 25-psi pressure (far beyond ordinary field conditions) has no effect on the FLUID-TITE joint.

For gravity sewer systems, "K&M" Asbestos-Cement non-pressure Pipe is the modern answer to the need for low-cost, permanent water-tight connections. The exclusive FLUID-TITE® Coupling makes installation quick and easy—and permanent.

No special equipment; little skill needed. Just two easy steps: 1. Lubricate rubber rings; 2. Slide pipe into coupling. The FLUID-TITE principle keeps piped fluids in, keeps external fluids and roots out, and allows pipe-laying that keeps up with the trench digger in speed. Installation costs go down when you specify the *modern* pipe and coupling system . . . "K&M."

Learn the advantages of the *modern* pipe from the K&M distributor. Or write to us for complete information.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

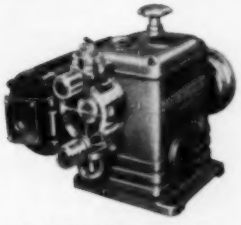
K·M
BEST IN ASBESTOS

Do You Feed ALUM?

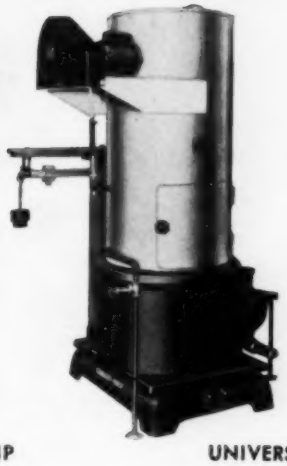
Liquid? Dry? By Weight? By Volume?

LOSS-IN-WEIGHT

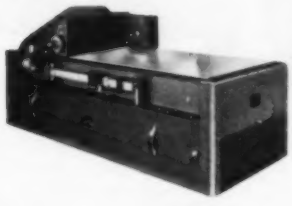
DISC



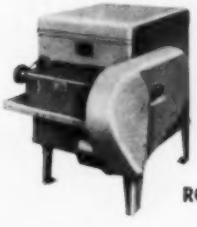
DIAPHRAGM PUMP



UNIVERSAL



GRAVIMETRIC



ROTODIP

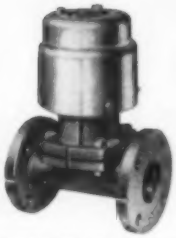
Omega offers the most complete line of ALUM FEEDERS . . . backed by a wealth of practical experience and equipment knowledge to help you get the right feeder for your specific requirements. Where desired, Omega is ready to supply auxiliary equipment and instrumentation: totalizers, master control panels, remote controls, proportional pacing systems, alarms, batch counters, and other related units.

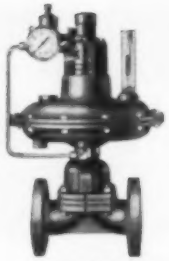
CLASS OF FEEDER	FEEDS ALUM—	FEEDING PRINCIPLE	SIZES	ACCURACY	CAPACITIES		RANGES
					MIN.	MAX.	WITHOUT CHANGE GEARS
Model 30 Loss-in-Weight	DRY	GRAVIMETRIC	3	± 1% by weight	10#/hr.	4000#/hr.	100:1
Model 50-8 Belt	DRY	GRAVIMETRIC	1	± 1% by weight	100#/hr.	3000#/hr.	100:1
Model 37-20 Belt	DRY	GRAVIMETRIC	1	± 1% by weight	500#/hr.	2000#/hr.	100:1
Model 50A Disc	DRY	VOLUMETRIC	1	± 3% by weight	40 cu. in./hr.	800 cu. in./hr.	20:1
Model 51 Disc	DRY	VOLUMETRIC	1	± 3% by weight	40 cu. in./hr.	6 cu. ft./hr.	100:1
Model 20 Universal	DRY	VOLUMETRIC	3	± 3% by weight	30 cu. in./hr.	85 cu. ft./hr.	40:1
Model 32 Loss-in-Weight	LIQUID	GRAVIMETRIC	3	± ½% by weight	5#/hr.	60,000#/hr.	25:1
Model 65 Rotodip	LIQUID	VOLUMETRIC	1	± 1%	5 GPH	1800 GPH	100:1
Model 47 Chem-O-Feeder	LIQUID	VOLUMETRIC	3	± 1% by weight	0.2 GPH	49 GPH	

For Bulletins describing any of the Feeder classes listed in the table, write **Omega Machine Co., 350 Harris Ave., Providence 1, R. I.**

OMEGA MACHINE CO.
DIVISION OF
B-I-F INDUSTRIES
METERS FEEDERS CONTROLS

Barber-Coleman


Bendix-Westinghouse Rotochamber


Conoflow

Fisher Governor

Foxboro Reversible Stabiflo

General Controls Hydramotor

GRINNELL-SAUNDERS DIAPHRAGM VALVES with famous name POWER OPERATORS

Grinnell Air Motor, Spring Loaded

Grinnell Air Motor, Double-Acting

Grinnell Piston

Hammel-Dahl Close-Coupled

Hammel-Dahl Preloaded

Kieley & Mueller

Mason-Neilan

Minneapolis-Honeywell

Philadelphia Gear Limitorque

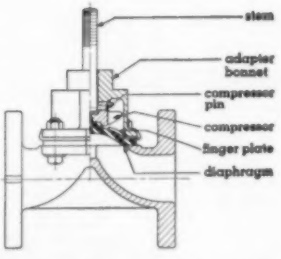
Taylor Motosteel

GRINNELL-SAUNDERS Diaphragm Valves are easily equipped for power operation — by combining any of numerous power operators, a sliding stem bonnet assembly, and a valve body. The sliding stem bonnet can be modified to accommodate any make of power operator, pneumatic or electric.

Grinnell-Saunders Diaphragm Valves are unsurpassed for handling materials as diversified as corrosive fluids, gases, beverages, foods . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors.

The operating principal of the Grinnell-Saunders Diaphragm Valve is simple. The resilient, flexible diaphragm is lifted high when the compressor is raised and pressed tight against the body weir when the compressor is lowered.

Grinnell valves are available with body, lining, and diaphragm materials to meet different service conditions. Write for further information.



This sliding stem bonnet is specially designed for power operation. The power operator is attached to the adapter bonnet and to the threaded end of its free-sliding stem. Thus, the operating force is applied *directly*. The stem, in turn, is directly connected to the compressor which opens and closes the valve when power is applied. This sliding stem bonnet is interchangeable with other bonnet designs.

GRINNELL
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

TENNESSEE CORPORATION

Ferri-Floc
FERRIC SULFATE

The Superior COAGULANT *With The Plus* FACTORS–

- Excellent taste and odor control
- Increased filter runs
- Coagulation over wide pH ranges
- Rapid floc formation ● Economy
- Turbidity removal ● Color removal
- Manganese and Silical removal
- Bacteria removal
- Ease of Operation

Ferri-Floc
FERRIC SULFATE

Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

WATER TREATMENT

Efficient coagulation of surface or well waters. Aids taste and odor control—Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial waters.

SEWAGE TREATMENT

Ferri-Floc coagulates water and wastes over wide Ph ranges—it provides efficient operation regardless of rapid variations of raw sewage and is effective conditioning sludge prior to vacuum filtration or drying on sand beds.

SULFUR-DIOXIDE HIGHEST QUALITY SO_2

SULFUR-DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

COPPER SULFATE

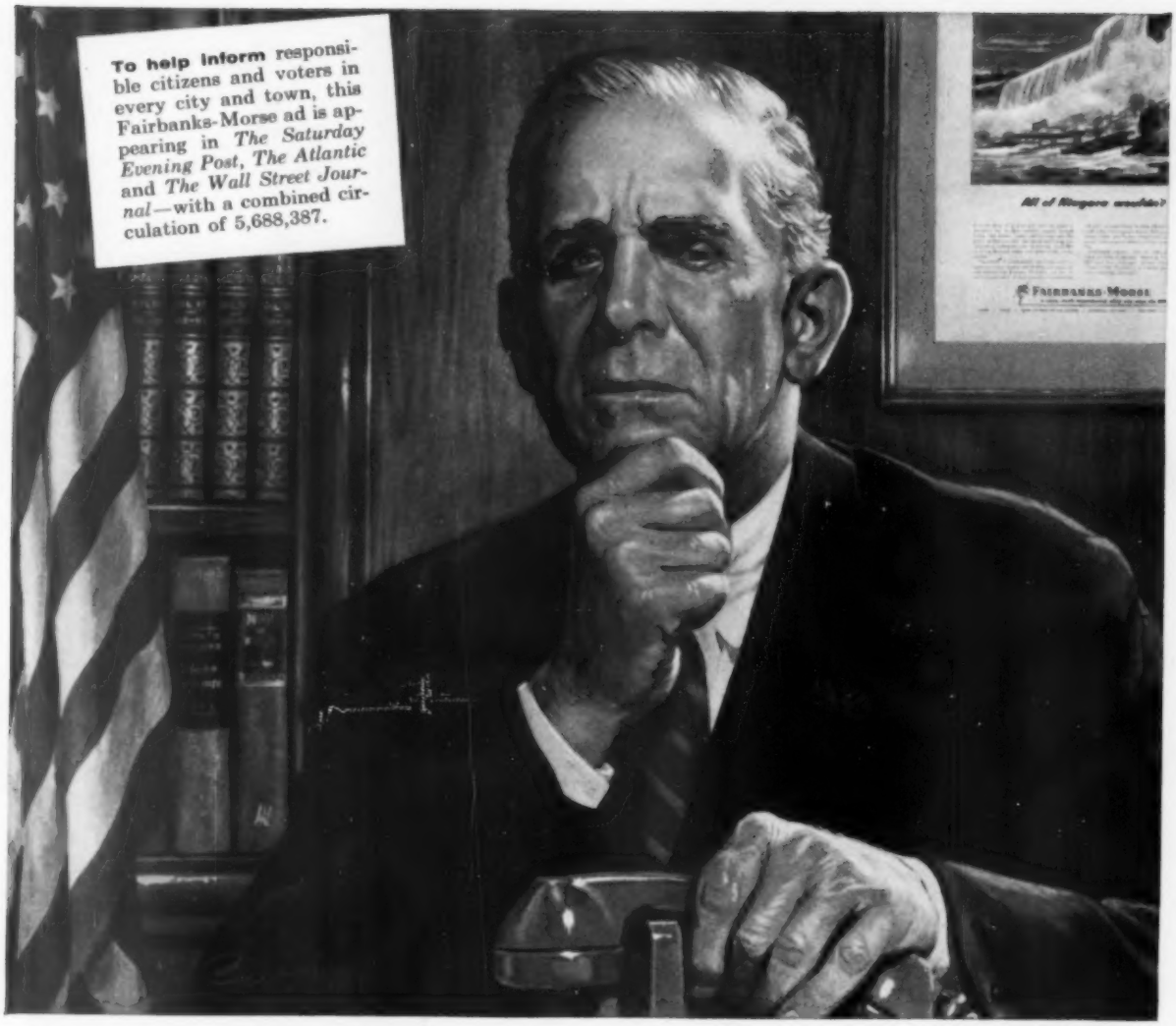
COPPER SULFATE will control about 90% of the microorganisms normally encountered in water treatment plants more economically than any other chemical.

TENNESSEE CORPORATION

617-629 Grant Building, Atlanta, Georgia

FREE BOOKLET

Let us send you without charge, a 38-page booklet that deals specifically with all phases of coagulation—just send us a postal card.


To help inform responsible citizens and voters in every city and town, this Fairbanks-Morse ad is appearing in *The Saturday Evening Post*, *The Atlantic* and *The Wall Street Journal*—with a combined circulation of 5,688,387.

His Honor, the Mayor, is worried

His Honor is worried. Insufficient water is drying up his town's future. Industries are hampered; fire protection is a question; new school programs are in jeopardy; outside industries are rejecting it as a new plant location . . . there are times when lawn sprinkling and car washing must be prohibited.

The Mayor is worried because he knows water rates are based on the costs of materials, machinery and construction of many years ago—that the time to enlarge water supply and distribution facilities is *now*, before these costs grow even higher.

As a citizen you also should be worried. You can aid your city officials by understanding the problem and supporting your mayor's efforts to finance needed expansions. Don't let lack of water stagnate your way of life and your town's future.

Interested citizens and city officials are invited to write Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois, for a copy of "Your 1100 Gallons," a timely booklet on what every citizen should know about water shortage problems.

PUMPS FOR	
☒	MUNICIPAL SERVICE
☒	INDUSTRY
☒	HOME
☒	AGRICULTURE

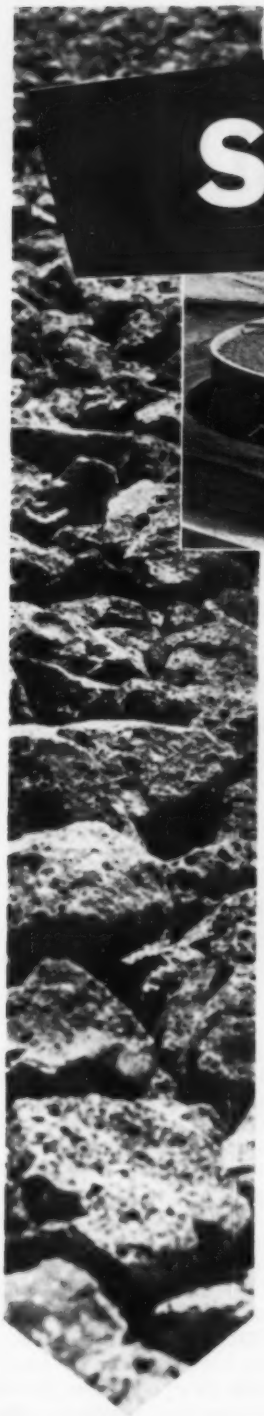
Fairbanks-Morse, the biggest name in pumps, provides pumps and power for every water need.

FAIRBANKS-MORSE
a name worth remembering when you want the BEST

PUMPS • SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • RAIL CARS • HOME WATER SERVICE EQUIPMENT • MAGNETOS

SLAG

The Efficient Trickling Filter Media



Slag is better because . . .

- **Air-cooled Blast Furnace Slag** is light in weight. This means a greater yield per ton.
- **Air-cooled Blast Furnace Slag** is durable–withstands many cycles of freezing and thawing.
- **Air-cooled Blast Furnace Slag** has a rough and vesicular surface that means greater adherence of plant and animal life.
- **Air-cooled Blast Furnace Slag** has the cubical shape that furnishes highest percentage of voids, necessary for the ready passage of sewage.

Recommended Gradings:

Passing 4″ sieve	100%
Passing 3½″ sieve	85 to 100%
Passing 2″ sieve	0 to 20%
Passing 1½″ sieve	0 to 10%

The above gradations are available from our plants. They have been successfully proved in use by many important plants. For complete details, further information and list of major successful users, *contact:*

Birmingham Slag Division
VULCAN MATERIALS COMPANY
P.O. Drawer 155 • Tel. FAirfax 2-3361 • Birmingham, Alabama

This is Vulcan Materials Company

Birmingham Slag Division • Vulcan Detinning Division
Southern Cen-Vi-Ro Pipe Corp. • Atlanta Aggregate Division
Stockbridge Stone Company • Teckote Corporation
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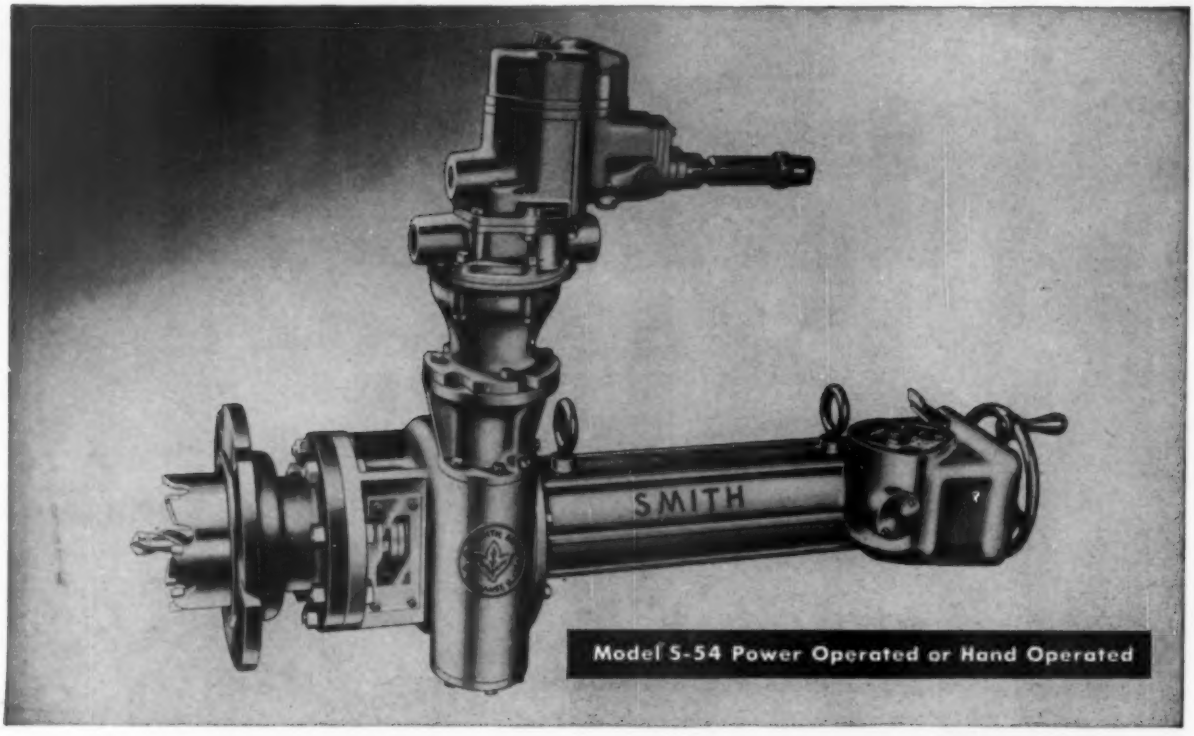
"Organized for Service"

Vulcan Materials Company

SMITH TAPPING MACHINES FOR TAPS 2" THRU 12" INCLUSIVE



Model S-54 Power Operated or Hand Operated

The A. P. Smith Mfg. Company in 1896 introduced the first Tapping Machine for making connections sizes 2" and larger to fluid and gas service piping under pressure. The Smith S-54 Tapping Machine is the most modern, efficient and economical machine available. S-54 Machines are produced with either 25" or 37" travel. The S-54 Smith Tapping Machine is used with Tapping Sleeves, Hat Flanges, Saddles and Tapping Valves to make 2" through 12" connections under pressure to Cast Iron, Cement-Asbestos, Steel and Reinforced Concrete Pressure pipe. Features: 1. AUTOMATIC FEED: Positive automatic feed insures correct drilling and tapping rate. Hand feed is provided to rapidly advance and withdraw Cutter. 2. TRAVEL INDICATOR: Chart attached to machine indicates travel required to complete tap. Travel is *AUTOMATICALLY* terminated when tap is completed. Cutter and shaft cannot overtravel. 3. COMPACT CONSTRUCTION: Telescopic shaft reduces overall length. 4. ENCLOSED CONSTRUCTION: Mechanism is housed in heat treated Aluminum Case filled with lubricant. Foreign matter cannot enter and damage mechanism. 5. STUFFING BOX AND PACKING GLAND: Accessible without disassembling machine. Equipped with Chevron packing. Line pressure cannot enter machine case. 6. RUGGED CONSTRUCTION: Extra large diameter telescopic shaft adds strength and rigidity. Timken radial—thrust bearings maintain alignment, reduce friction and wear. 7. DRIVING GEARS: Worm gearing operates in lubricant, torque is reduced to the minimum. 8. CUTERS: Have replaceable Flat and Semi-V alternate teeth of High Speed Steel or Tungsten Carbide. 9. FLEXIBILITY: Hand Operated Machines can be converted to Power Operation by interchanging worm gearing. 10. AIR MOTOR: The motor attaches directly to the Power Operated Machine without Brackets, Holders or Adapters. Bulletin sent on request.

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FIRE HYDRANTS · VALVES · SINCE 1896

THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

Wrought Iron Pipe's built-in protection ...always "on guard" against corrosion

Wrought iron pipe's "armed guard" against corrosion is a concentration of thousands of glass-like iron silicate fibers distributed throughout the metal.

These iron silicate fibers are relatively immune to corrosion . . . so any attacks by corrosion are evenly dispersed over the entire surface of the metal. As a result of this built-in protection, deep pitting and penetration are repelled . . . costly premature repairs and maintenance are eliminated.

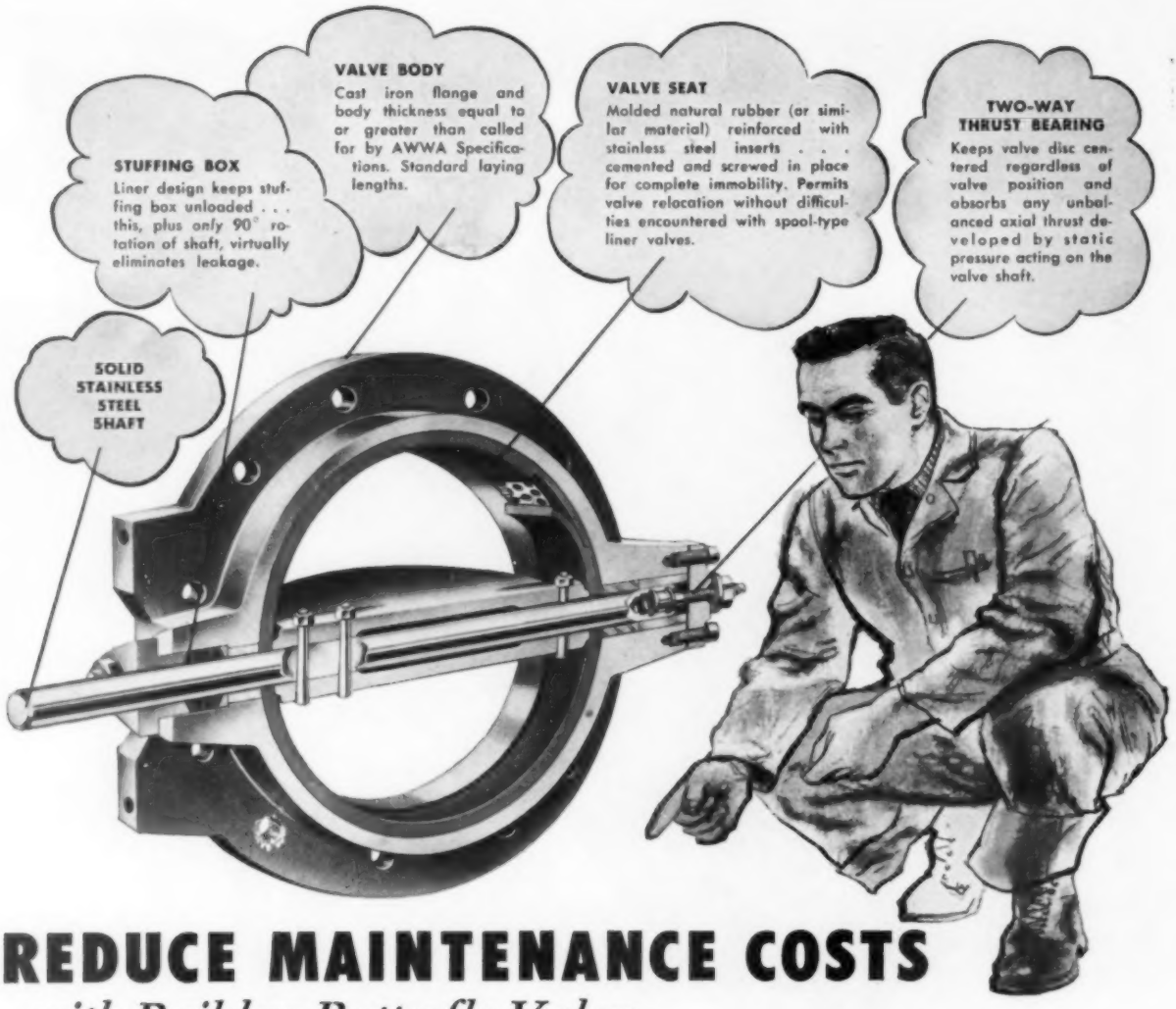
Our booklet, "The ABC's of Wrought Iron" tells more of this story. You'll find it profitable reading. Write for your copy today.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y.

Available in Canada and throughout the world.

BYERS Wrought Iron Tubular and Hot Rolled Products

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS


STUFFING BOX
Liner design keeps stuffing box unloaded . . . this, plus only 90° rotation of shaft, virtually eliminates leakage.
VALVE BODY
Cast iron flange and body thickness equal to or greater than called for by AWWA Specifications. Standard laying lengths.
VALVE SEAT
Molded natural rubber (or similar material) reinforced with stainless steel inserts . . . cemented and screwed in place for complete immobility. Permits valve relocation without difficulties encountered with spool-type liner valves.
TWO-WAY THRUST BEARING
Keeps valve disc centered regardless of valve position and absorbs any unbalanced axial thrust developed by static pressure acting on the valve shaft.
SOLID STAINLESS STEEL SHAFT

REDUCE MAINTENANCE COSTS

with Builders Butterfly Valves

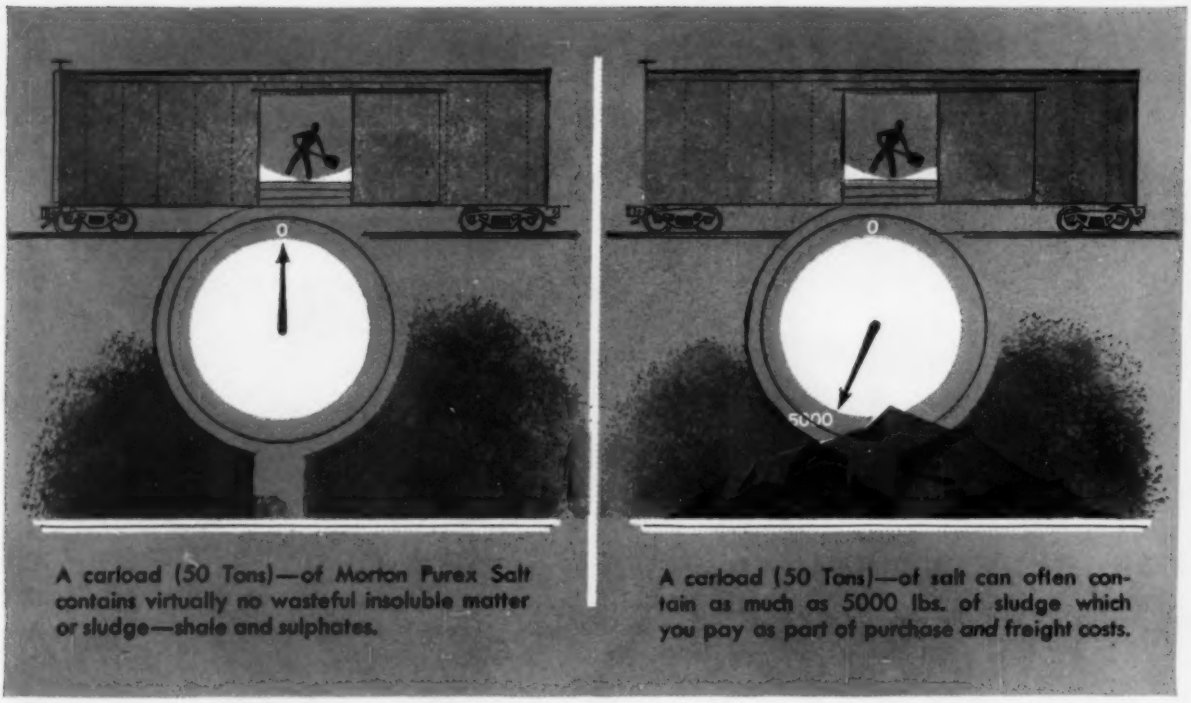
Available with all types of manual and power operators, including Builders own "lo-head" cylinder operator.

Strict adherence to sound engineering and advanced hydraulic principles accounts for the high durability of Builders Butterfly Valves. These design features, plus extra-sturdy construction result in valves which last the life of the plant and require minimum maintenance.

Remember, too, that these Butterfly Valves are backed by Builders specialized knowledge of water and sewage works metering and control problems. Builders Butterfly Valves are built to AWWA specifications . . . for water and sewage works service.

For Bulletin 650-L1B, write
BUILDERS-PROVIDENCE, INC.
350 Harris Ave., Providence 1, R. I.

BUILDERS-PROVIDENCE
DIVISION OF
B-I-F INDUSTRIES
METERS FEEDERS CONTROLS

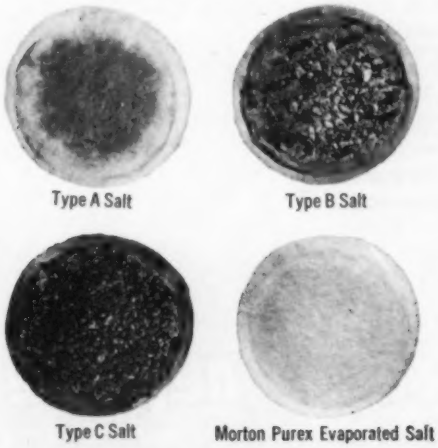


A carload (50 Tons)—of Morton Purex Salt contains virtually no wasteful insoluble matter or sludge—shale and sulphates.

A carload (50 Tons)—of salt can often contain as much as 5000 lbs. of sludge which you pay as part of purchase and freight costs.

Stop paying for wasteful sludge —switch to Purex Salt

These filter pads (approximately 1/5 actual size) show you how much insoluble matter (sludge) you get in just 5 lbs. of various kinds of salt.



Type A Salt

Type B Salt

Type C Salt

Morton Purex Evaporated Salt

Tests for insolubles taken from random samples show you that Morton Purex is the only one that contains no wasteful sludge or insolubles.

For more information about Morton Purex Salt, and for free, expert help on any water-softening problem, write:

When you buy Morton Purex Salt, you get high purity evaporated salt that is made in a controlled-particle size to prevent packing and channeling. With Purex, none of your purchase price or freight bill goes toward paying for useless, troublesome insoluble matter.

With Morton Purex, no time or labor is wasted in cleaning out insoluble matter from your brine making system to keep it functioning at peak capacity. For Purex is 100% soluble. Morton Purex will leave no accumulation of material in either brine or water softener tanks. It can be used in wet-storage systems, and in the Morton Model-E Brinemaker.

MORTON SALT COMPANY

INDUSTRIAL DIVISION

Dept. W11, 120 So. LaSalle Street
Chicago 3, Illinois

FOR BETTER RESULTS
WITH LESS TROUBLE
...PICK *ONE*
INSTEAD OF TWO

1½" or 2" Style 3 Meter matches performance of complicated compound . . . with less cost and fuss

For 1½" and 2" water service lines, the Trident Style 3 meter is simpler, costs less to buy and maintain, is every bit as accurate, and produces just as much revenue over a wide range of flows as any compound, including our own. Trident was *first* to give you an easy-to-set pressure adjustment. And since modern Style 3 parts fit older meters, there's never any obsolescence.

So why put up with the fuss and expense of *two* measuring units when one Style 3 will do the job? You'll find conclusive evidence in your own records . . . or ask your Neptune man.

270

NEPTUNE METER COMPANY
19 West 50th Street • New York 20, N. Y.

NEPTUNE METERS, LTD.
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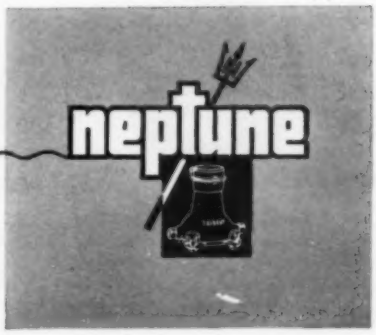

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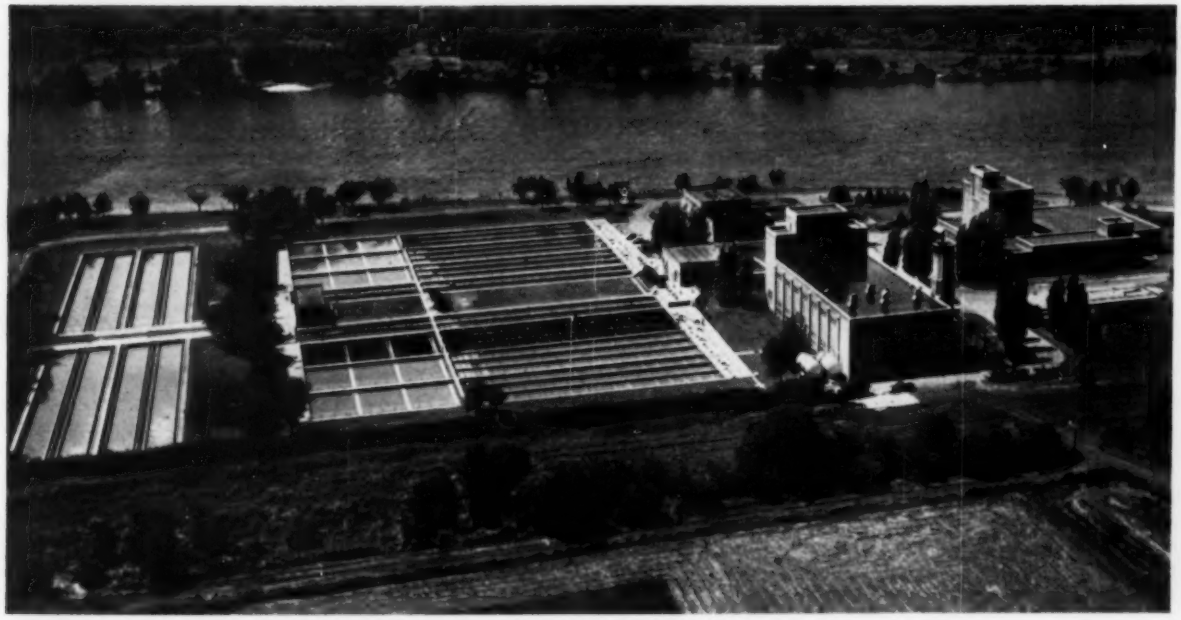


TWIN CITIES plant incinerates vacuum dried raw sludge

An Examination of Sewage Solids Incineration Costs

by KERWIN L. MICK and SCOTT E. LINSLEY

Mr. Mick, Chief Engineer and Mr. Linsley, Assistant Engineer, Minneapolis-St. Paul Sanitary District, present an objective analysis that should be of interest to all persons concerned with the cost of incineration of sewage solids.

A COMPREHENSIVE examination of sewage solids incineration costs can serve several useful purposes, as follows:

1. It can aid in determining whether or not incineration is the proper method of final solids disposal for a particular sewage treatment objective.

2. It can determine which of the incineration systems available is the most economical to operate.

3. With similar systems, it can provide a basis of comparison for properly operating the system and set guides and limits to maintenance, attendance, and other service factors in order to obtain maximum capacity and efficiency.

In order to properly evaluate each of these purposes, however, an understanding of the problems involved and their various facets must be obtained. It must be recognized first of all that the incineration operation cannot be considered completely independent of the other sewage treatment processes, as to do so would result in failure to obtain a proper balance between investment cost and operating cost and, thus, an improper total vestance[1].

That the foregoing statement is true will be immediately apparent if we consider that the nature of the material to be burned is drastically affected by the manner in which the solids in the sewage are handled. Sewage solids as removed normally include screenings, grit, scum, and sludge. Each of these items contains varying amounts of water, volatile or combustible matter, and ash.

Further, the fuel value on the basis of Btu's per pound of dry solids varies. This variation is particularly apparent when raw sludge is compared with digested sludge.

Also, simple mathematics shows that a minimum of water is desirable if combustion is to be self-sustaining (without the use of expensive fuels). A little investigation will demonstrate that in order to obtain a reasonably economic incineration heat balance, additional dewatering of the sludge is essential beyond simple concentration. This is commonly accomplished by vacuum filtration.

Thus, until newer, more economical

Table 1—Comparison of Sewage Treatment Plant Costs and Accomplishments

Item No.	Item	Computation Reference	Unit	Buffalo [4] Fiscal Year 1955-1956	Cleveland [5] Calendar Year 1955*	Detroit [6] Fiscal Year 1955-1956	Mpls.-St. Paul [7] Calendar Year 1955
	General load data:						
1.	Connected Population	.....		576,000	1,229,029†	2,600,000	958,000
2.	Population equivalent	.....		786,000	1,658,228†	2,620,000	1,510,000
3.	Area served	.....	Sq Mi	42	109	331	229
4.	Sewer system length	.....	Miles	775	Not avail.	2,770	2,038
5.	Plant effluent flow	.....	Avg. Cfs	222	53 W 158 E 92 S	735	210
6.	Flow in river at outfall	.....	Avg. Cfs	200,000	Lake Erie plus 295	177,000 ‖ ¶	7,410
7.	Rainfall (total for year)	.....	In.	44.0	39.6	33.3	21.1
8.	Effluent 5-day BOD avg.	.....	Ppm	84.0	137 W 13.2 E 70 S‡	82.6	155
9.	Plant construction cost	.....	$	5,209,826.35	16,852,378.21	10,726,551.35	3,932,762.49
10.	Date of completion of original plant constr.	.....	Yr.	1939	1932-1936 W 1938 E, S	1940	1938
11.	Total operating expense	.....	$	779,726.43	2,119,737.17	2,623,706.62	829,326.83
12.	Sewage treated:	.....	Mg	52,172	71,647	173,714	48,272
13.	Avg. sewage strength (sus. solids)	.....	Ppm	146	256 W 196 E 224 S	225	284
14.	Removal of sus. solids by plant	.....	%	34.2	29.4 W 93.0 E 25.9 S§	48.1	70.7
15.	Removal of 5-day BOD	.....	%	23.6	25.1 W 90.2 E 50.9 S§	30.6	35.4
16.	Avg. sewage strength in 5-day BOD	.....	Ppm	110	183 W 135 E 143 S	119.1	240
	Removal of dry solids:						
17.	Screenings and trash	.....	Tons	651	37¶	Incl. in scum and sludge	138
18.	Grit	.....	Tons	1,354	7,086☆	12,123	10,012
19.	Scum	.....	Tons	Incl. with sludge	Incl. with sludge	1,189	1,057
20.	Sludge	.....	Tons	7,508	39,188	79,950	44,126
21.	Total	.....	Tons	9,513	46,311	93,262	55,333
	Removal of volatile matter:						
22.	Screenings and trash	.....	Tons	Not avail.	Not avail.	Incl. in scum and sludge	122
23.	Grit	.....	Tons	551	2,679	3,633	1,041
24.	Scum	.....	Tons	Incl. with sludge	Incl. with sludge	1,070	1,034
25.	Sludge	.....	Tons	5,040	29,120	48,897	31,991
26.	Total	.....	Tons	5,591	31,799	53,600	34,188
27.	Removal of 5-day BOD:	.....	Tons	5,660	28,056	26,332	17,120
	Sludge conditioning chemicals, % of dry weight of sludge solids:						
28.	Ferric chloride (or equiv.)	.....	%	4.41	3.0‡ W 3.8 S	1.07	0.47
29.	Calcium oxide (lime)	.....	%	17.22	13.1 W 12.1 S	10.53	2.42
30.	Cost of operation● :	.....	$	487,959.41	1,561,566.34	1,133,394.74	829,326.83
31.	Cost per mg treated★	30/12	$	9.35	21.80	6.53	17.18
32.	Cost per ton dry solids removed★	30/21	$	51.29	33.72	12.15	14.99
33.	Cost per ton volatile matter removed★	30/26	$	87.28	49.11	21.14	24.26
34.	Cost per ton BOD removed★	30/27	$	86.21	55.66	43.04	48.44

* Three plants: W = Westerly, E = Easterly, S = Southerly.

† For calendar year 1956.

‡ Weighted average effluent BOD, including supernatant liquor from digestion tanks discharged to outfall sewer.

§ Neglecting the supernatant liquor discharged to the outfall sewer, the suspended solids removal increases to 72.5% and the BOD to 67.9%.

‖ This plant processes all of the Easterly plant's sludge in addition to that removed locally.

¶ Screening dry solids = 7.5 lb per cu ft (estimated), balance in sludge.

☆ Grit: Dry solids = 85 lbs per cu ft (estimated).

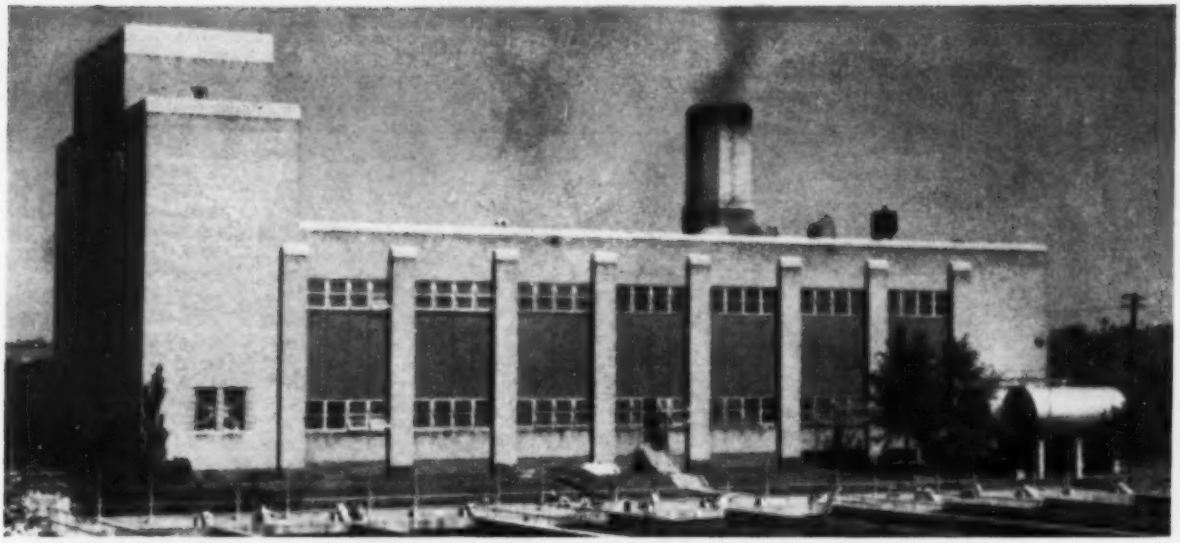
● Chlorination, depreciation, and pumping costs excluded.

★ Items 31 through 34 are partial unit costs, but are truly comparable. See text for discussion of cost comparability. Actual over-all costs are seldom comparable between different plants. Detroit Annual Report, for example, present over-all costs as follows:

Total cost of sewage disposal operation and maintenance, 1955-6 ..... $2,623,706.62 (Item 11).

Cost per million gallons = ... $ 15.10 instead of $6.53 (Item 31).

Cost per ton solids disposed of by incineration (dry basis) (including chemicals) (Item 11, Table 1 ÷ Item 32, Table 2) = ... $ 31.13 instead of $12.15 (Item 32).



SLUDGE filtration and incineration building concentrates all processes of dewatering in one unit.

methods are proven, the vacuum filtration process must be considered as an integral part of the incineration operation. For the purpose of adequate cost control, detailed information must be available on each department[2].

A system is involved; therefore, a system study is in order. No part of the system can be omitted from consideration or the whole will not be properly evaluated.

Further, when comparing capital costs, the prevailing wage rates in a given area are of importance as well as the time of construction. Because the value of the dollar has varied widely in recent years, it is important that original capital investments be re-evaluated in terms of present-day replacement costs. For purposes of this discussion, the *Engineering News-Record* Construction Cost Index is used as a basis for comparison.

The sewage and industrial wastes field suffers from a lack of uniformity in accounting and reporting procedure[3]. This is due in part to process differences, trade secrets, patents, and magnitude of the art. The principal reason for public utility reporting divergence probably is due to the area of responsibility and the political organizational limits involved. Thus, those factors for which an organization is not responsible will not ordinarily be reported by the individual in charge.

It is suggested that regardless of the organizational responsibilities involved, a uniform system of accounting for sanitary districts and sewage plants be adopted showing full and complete costs on a comparable process basis. Thus, the principal Roman numeraled operating and capital cost divisions listed hereinafter should be expanded to provide for other major items such as interceptors, pumping, aeration, biological filtration, digestion, and lagoon or drying bed operation, including hauling.

To rationalize performance and cost data acquired from various sources, Table 1 has been prepared showing a comparison of sewage treatment plant costs and accomplishments for four different cities. The bulk of this information has been compiled or computed from the annual reports of the organizations cited in the references or from other sources shown. This table provides a common ground for comparing data, or points out the lack thereof as the case may be.

The sewage treatment plants of Buffalo, N. Y.; Cleveland, Ohio; Detroit, Mich.; and Minneapolis-Saint Paul, Minn., were selected for comparison because they all operate incinerators, publish extensive annual data, and are of similar magnitude. The degree of treatment and the nature of some of the processes vary between the different plants; but there are some comparable processes, and these are the ones discussed in the following.

Operating Costs

To ensure as far as possible that similar items are compared and that a proper reporting basis has been achieved, a brief discussion of the cost figures in Table 1 follows:

The total operating expense, Item 11, is not comparable for the cities cited. This is true because of differences in size of the cities and a number of other factors, such as hydraulic characteristics, type of treatment, etc. Sewage flow in the Minneapolis-Saint Paul area is approximately 98 percent by gravity; thus, the pumping costs are negligible at this plant. Cleveland's sewer system is also largely gravity flow, although some 20 mgd (about 11 percent) are pumped and these costs are largely charged to the Easterly plant. Conversely, all of Detroit's and Buffalo's sewage is pumped.

Further, chlorine is not used at Minneapolis-Saint Paul, but is used in considerable quantities at Buffalo, Cleveland, and Detroit. Costs reported for Cleveland and Detroit include a substantial figure for depreciation, whereas none is allocated for Buffalo or Minneapolis-Saint Paul. Buffalo, Cleveland Westerly, Detroit, and Minneapolis-Saint Paul are primary treatment plants only, but Cleveland Easterly and Cleveland Southerly perform secondary treatment and thus are most costly to operate.

Item 30, another basis for reporting the cost of operation, is more comparable and uniform because it includes the operating costs for all plants, less chlorination, depreciation, and pumping costs allocated, plus the proportionate share of administrative costs including billing and collection. The unit costs in Items 31 through 34 inclusive, are based on Item 30 divided by the appropriate quantities shown.

Table 2 has been prepared with the objective of segregating the different processes pertaining to the various materials removed from the sewage, with particular emphasis on those directly related to incineration. The total process cost, Items 55 through 58 in Table 2, is extracted from Item

Table 2—Comparison of Sewage Solids Incineration and Associated Operating Total Disposal Cost Factors

Item No.	Item	Computation Reference	Unit	Buffalo [6] Fiscal Year 1955-1956	Cleveland [8] Calendar Year 1955 Southerly Only	Detroit [9] Fiscal Year 1955-1956	Mpls.-St. Paul [7] Calendar Year 1955
1.	Type of incinerators			Gas & oil fired flash drier	Mult.-hearth (8 hearths)	Mult-hearth (11 hearths)	Mult.-hearth (8 hearths)
2.	No. of units installed			3	4	4	4
3.	Cap. of each incin.:				18'-9" dia.	22'-3" dia.	22'-3" dia.
4.	Dry solids per day		Tons	30	25	110.1	75
5.	Combustible per day		Dry tons	14.6	12.5	53.9	38.4
6.	Water evaporation per day		Tons	70	75	189.9	144
7.	System capacity			Three times unit cap.	Four times unit cap.	Four times unit cap.	Four times unit cap.
	Ultimate analysis of sludge cake, combustible basis:				Sludge (not cake)	Grab sample	
8.	Carbon		%	Not avail.	64.34	65.57	55.00
9.	Hydrogen		%	Not avail.	8.21	8.96	7.36
10.	Oxygen		%	Not avail.	20.97	20.92	33.40
11.	Nitrogen		%	Not avail.	4.30	3.40	3.09
12.	Sulfur		%	Not avail.	2.18	1.15	1.15
13.	Total		%	100	100	100	100
14.	Combustible, dry basis		%	Not avail.	47.87	51.43	72.5
15.	Heat in Btu lb comb.			10,325	12,156	12,900	10,000
	Vacuum filtration:						
16.	Vol. matter in cake		Tons	3,079	6,381	36,571	31,358
17.	Cake produced		Dry tons	7,242	16,684	71,089	44,475
	Incineration:						
18.	Operating days			284	365	365	354
19.	Inc. system time load factor		%	32.3	48.0	75	88
20.	Inc. unit comb. load factor	26/5	%	59.6	69.6	69.6	65
21.	Inc. unit water evap. load factor	27/6	%	47.0	79.2	69.5	56
22.	Inc. unit dry sol. load factor		%	68.3	92.1	69.7	47.5
23.	Wet feed rate/hr./incin.		Tons	2.22	3.39	8.70	5.43
24.	Dry solids in matl. incin.		%	38.5	27.7	36.8	27.3
25.	Combustible in above		%	42.5	38.2	48.9	70.5
26.	Comb. burned/incin. day		Tons	8.7	8.7	37.6	25.1
27.	Water evap./incin. day		Tons	32.9	59.4	132.0	94.8
28.	Fuel oil/wet ton burned		Gal.	0	0.175	0.205	0.14
29.	Sludge gas/wet ton burned		cu ft	7,020	588	0	0
30.	Material incinerated:			Digested sludge cake	Digested sludge cake	Grit, scum, raw sludge cake, some dig. sludge	Raw sludge cake only
31.	Wet solids, total		Tons	18,885	58,165	229,211	162,630
32.	Dry solids, total		Tons	7,242	16,137	84,290	44,441
33.	Volatile matter (comb.)		Tons	3,079	6,172	41,234	31,335
34.	Water evaporated		Tons	11,643	42,028	144,927	118,189
35.	Ash produced		Tons	4,163	9,965	43,056	13,106
36.	Digestion (vol. converted to gas)		Tons	3,289	14,985	2,520	0
37.	Vol. matter destroyed (dig. + incin.)		Tons	6,368	21,157	43,754	31,335
	Dry sewage solids:						
38.	Converted to gas in dig.		Tons	3,289	14,985	2,520	0
39.	Vacuum filtered		Tons	5,515	12,508	64,839	44,126
40.	Incinerated		Tons	5,515	12,051	78,041	44,094
41.	Total in sludge only		Tons	8,804	27,493	67,359	44,126
42.	Total (38 + 39 + 40)		Tons	8,804	27,493	80,561	44,126

30 in Table 1 and includes all the properly chargeable overhead, but excludes depreciation.

The direct process costs in Items 43 through 46 are all the process costs, including maintenance, but less administrative overhead charges.

The unit costs shown in Table 2 are largely self-explanatory, but a few comments are in order. The unit costs shown in Items 49, 51, 61, and 62 are proportionally lower for Detroit when compared to the other plants, due to grit incineration at Detroit.

Certain technical data have been included in Table 2 as they have a bearing on cost. For example, to properly analyze heat balance factors the ultimate analysis of the sludge must be known. Further, if this analysis is performed on the sludge cake, proper consideration of the quantity and kind of chemicals added will have to be made in order to accurately calculate the fuel value [11], a necessary preliminary to capacity and operating cost determination.

The unit costs per ton of volatile matter destroyed afford perhaps the most descriptive and comparable figures for the results obtained in all plants, as a measure of work done.

Capital Costs

Comparison of Plant Construction Costs Difficult

The plant construction costs, Item 9, Table 1, are not comparable. Some of the reasons for this fact have been previously outlined. The same reasons given for the non-comparability of Item 11, total operating expense, also apply here.

Acquisition of data or replacement, is difficult; however, these costs are given for the Minneapolis-Saint Paul plant. Such data provide current construction cost information and make possible total vestance comparisons for selection of the most economical type of installation for a particular sewage treatment objective.

Plant Construction Costs By Principal Divisions

The Minneapolis-Saint Paul Sanitary District normally reports costs allocated between some 23 departments; however, for the purpose of comparison between plants, these accounts

Table 2 (Cont.) Comparison of Sewage Solids Incineration and Associated Operating Total Disposal Cost Factors

Item No.	Item	Computation Reference	Unit	Buffalo [4] Fiscal Year 1955-1956	Cleveland [5] Calendar Year 1955 Southerly Only	Detroit [6] Fiscal Year 1955-1956	Mpls.-St. Paul [7] Calendar Year 1955
	Direct proc. costs (Incl. maint.):						
43.	Digestion and conc.	.....	$	96,480.43	96,678.93	4,323.41	0
44.	Vacuum filt. and conc.	.....	$	68,325.41	207,374.03	221,932.14	171,266.98
45.	Inc. and ash disposal	.....	$	84,703.04	109,691.81	382,154.02	95,875.03
46.	Sum. direct proc. costs	.....	$	249,508.88	413,744.77	508,409.57	267,142.01
	Direct cost of proc. per ton of dry sew. sol.:						
47.	Converted to gas in dig.	43/38	$	29.33	6.45	1.72	0
48.	Vacuum filtered	44/39	$	12.39	16.58	3.42	3.88
49.	Inc. and ash disposed of	45/40	$	15.36	9.10	4.90	2.17
50.	Direct cost of disposal per ton of dry sludge sol. only	46/41	$	28.34	15.05	9.03	6.05
51.	Direct cost of disposal per ton of dry sew. sol. in 47, 48, 49	46/42	$	28.34	15.05	7.55	6.05
	Direct cost of proc. per ton of vol. matter:						
52.	Converted to gas	43/36	$	29.33	6.45	1.72	0
53.	In filter cake	44/16	$	22.19	32.50	6.07	5.46
54.	Incin. and ash disposed of	45/33	$	27.51	17.77	9.27	3.06
	Total process costs:						
55.	Digestion	.....	$	134,658.59	122,886.57	5,583.29	0
56.	Vacuum filtration	.....	$	96,959.03	263,588.80	286,605.23	331,654.97
57.	Incin. and ash disposal	.....	$	141,970.29	139,426.98	493,517.26	185,660.02
58.	Total disposal cost	.....	$	373,587.91	525,902.35	785,705.78	517,314.99
	Total cost of proc. per ton of dry sewage sol.:						
59.	Converted to gas	55/38	$	40.94	8.20	2.22	0
60.	Vacuum filtered	56/39	$	17.58	21.07	4.42	7.52
61.	Incin. and ash disposed of	57/40	$	25.74	11.57	6.32	4.21
62.	Total cost of disp. per ton of dry sewage sol. in 59, 60, 61	58/42	$	42.43	19.13	9.75	11.72
	Total cost of proc. per ton of vol. matter:						
63.	Converted to gas	55/36	$	40.94	8.20	2.22	0
64.	In filter cake	56/16	$	31.49	41.31	7.84	10.58
65.	Incin. and ash disposed of	57/33	$	46.11	22.59	11.97	5.93
66.	Direct cost of disp. per ton of vol. matter destroyed	46/37	$	39.18	19.56	13.91	8.53
67.	Total cost of disp. per ton of vol. matter destroyed	58/37	$	58.67	24.86	17.96	16.51

Disposal cost = sum of concentration + digestion + vacuum filtration + incineration + ash handling costs.

Note: Table does not include capital costs and depreciation. See Tables 3 and 4, as well as text, for a method of computing these items.

have been combined into the following principal divisions:

I. Screenings and grit removal and disposal.
II. Chemical handling, feeding, and disinfection.
III. Flocculation, sedimentation, and scum removal and disposal.
IV. Sludge concentration and vacuum filtration.
V. Incineration and ash disposal.

The operating costs reported in Table 2 conform to these principal divisions. The capital costs, discussed presently, also conform to these principal divisions.

The original cost (construction, engineering, and overhead) of the Minneapolis-Saint Paul sewage treatment plant was $3,932,762.49. This cost, broken down into the previously described divisions, is shown in Table 3. Further, the EN-R Construction Cost Index at the time of construction in 1935-8 averaged 200. The cost of subsequent additions and subtractions is shown, as well as the replacement cost of each division, with the additions adjusted for the proper EN-R Construction Cost Index ratio at the time of change to a present cost (January 1957) with an EN-R Construction Cost Index of 700.

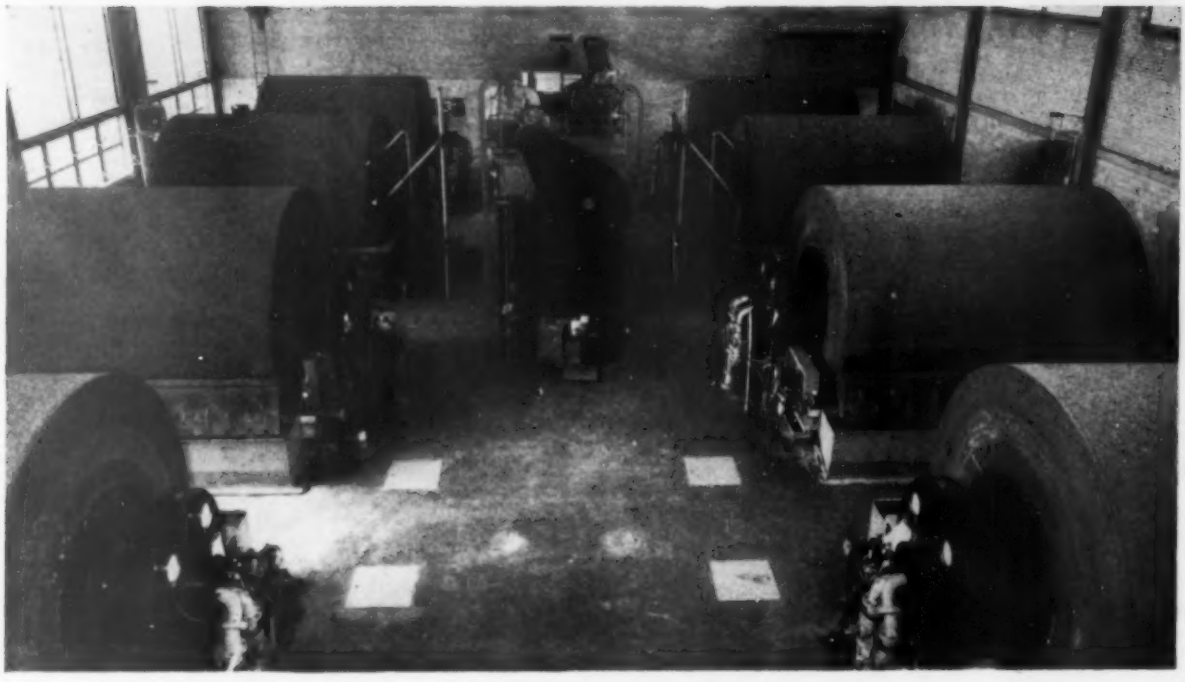
Construction Costs Per Unit of Capacity

Inspection of Table 2 will reveal a Minneapolis-Saint Paul incineration system capacity as follows:

Dry solids per day.....300 tons
Combustible per day.....154 tons
Water evaporation per day....576 tons
*Simultaneously.

The figure given for capacity in terms of dry solids is, of course, affected by the moisture and combustible content of the cake, but the figure given may be considered as a "mechanical capacity"; that is, it represents roughly the quantity that can be physically handled in the system.

But the *economic vacuum* filter capability of the present filter installation (4,000 sq ft) will reduce the dry solids figure to about 240 tons per day for the over-all system. Using the over-all figures, the present installed sludge disposal construction costs per unit of capacity are approximately as follows:



EIGHT vacuum filters dewater sludge to cake for incinerator feed.

$20,100 per ton of dry solids per day, or
$31,300 per ton of combustible destroyed per day, or
$8,370 per ton of water evaporation per day.

This is derived from the data in Table 3 (Item IV + V ÷ plant capacity in terms of dry solids, combustible, or water evaporation). This amounts to $4,820,000 ÷ plant capacity.

Vestance[1]

From Table 3, the total present replacement cost of the sludge disposal equipment including the building and other structures is $4,820,000. These fixed assets are divided approximately as follows: 50% equipment, 50% long-lived structures and apparatus. The former has been assigned a depreciation rate of 4%, or a life of 25 years; the latter has been assigned a depreciation rate of 1⅓%, or 75 years. This amounts to an over-all depreciation rate of about 2⅔%. An interest rate of 5% has been chosen for money costs and debt servicing.

Let
C = first cost;
n = life, in years;
R = interest rate = 0.05;
a = operating cost per year;
V = vestance, the total present cost of a permanent service = $V_d + V_o$;

$$T = \text{term factor} = \frac{(1+R)^n - 1}{(1+R)^n};$$

$$V_d = \text{depreciation vestance} = \frac{C}{T};$$

$$V_o = \text{operating vestance} = \frac{a}{R};$$

A = total annual cost = RV;
e = equipment; and
s = structures.

Substituting from Table 2, Item 58, and from Table 3, Items (IV+V)÷2.

$$V_o = \frac{a}{R} = \frac{\$517,314.99}{0.05} = \$10,346,200.00$$

$$V_{d_e} = \frac{C_e}{T_{25}} = \frac{\$2,410,000.00}{0.52241} = \$\ 4,613,200.00$$

$$V_{d_s} = \frac{C_s}{T_{75}} = \frac{\$2,410,000.00}{0.97425} = \$\ 2,473,700.00$$

$$V = \$17,433,100.00$$

$$A = RV = 0.05 \times \$17,433,100 = \$871,655$$

Thus, the 1955 Minneapolis-Saint Paul District total unit sludge disposal costs were as follows:

$$\frac{\$871,655}{44,126} = \$19.75 \text{ cost ton dry sewage solids}$$

$$\frac{\$871,655}{31,335} = \$27.82 \text{ cost per ton of volatile matter destroyed}$$

(See Items 42 and 37, Table 2.)

Conclusion and Discussion

The previous section is an examination of all solids disposal costs for a

Table 3—Minneapolis-Saint Paul Sanitary District Sewage Treatment Plant Capital Costs

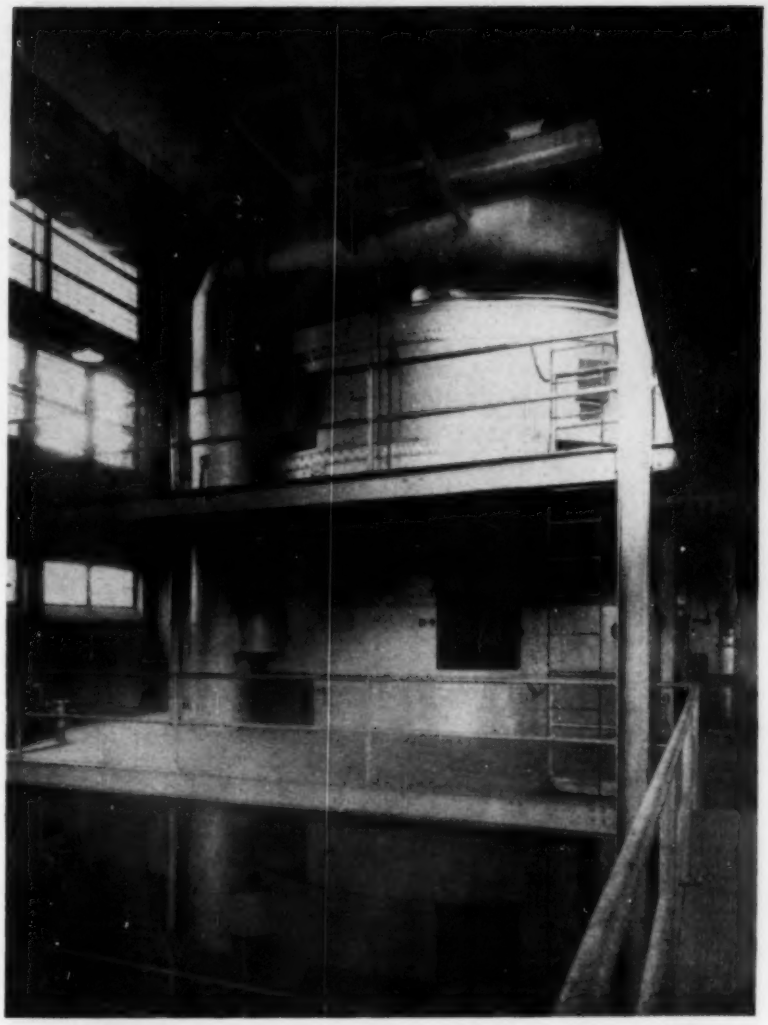
Cost Item	Description	Original Plant Cost	Original Cost Adjusted to Jan. 1, 1957	Sum of Present Value of Additions and Subtractions	Replacement Cost of Existing Plant	% of Total
Index	EN-R Construction Cost Index	200	700	700	700	
I	Screenings + grit removal + disposal	$ 484,442.04	$ 1,695,000	$— 31,000	$ 1,664,000	13.2
II	Chemical handling, feeding and disinfection	207,163.11	725,000	+ 2,000	727,000	5.8
III	Floc., sed., scum removal and disp.	1,897,789.46	6,640,000	—1,222,000	5,418,000	42.9
IV	Sludge conc. and vacuum filt.	580,201.41	2,030,000	+ 20,000	2,050,000	16.2
V	Incineration and ash disposal	763,346.47	2,670,000	+ 100,000	2,770,000	21.9
Total	Complete plant values	$3,932,762.49	$13,760,000	$—1,131,000	$12,629,000	100

sewage treatment plant. The only factor which might not have been adequately considered is that of obsolescence, which is usually a somewhat unknown quantity.

The total unit sludge disposal costs for the Minneapolis-Saint Paul plant, previously computed under "Vestance," which give proper consideration to all facets of operating and capital costs, are considerably lower than those quoted for Cleveland and elsewhere by Wirts [3]. It would appear that this is due to utilization of the raw rather than the digested sludge process at Minneapolis-Saint Paul, plus low initial capital costs, as well as different methods of treating capital costs.

It appears that after the sewage treatment requirements in respect to degree of treatment have been determined for new sewage treatment plant facilities, either for an original plant or for the expansion of an old one, more comparative vestance [1] or capitalized[10] cost studies of various processes should be made before new construction is attempted.

The manner of operation of an incinerator system has an important effect on cost. Of prime importance is operator training, initiative, and the availability of an up-to-date set of operating instructions. No less important is the need for modern control and measurement apparatus and the associated equipment to carry out the changes indicated or required by the system controls. These factors are instrumental in obtaining maximum system capacity and, thus, minimum investment costs as well as minimum maintenance.



MULTIPLE-HEARTH incinerator is one of four in Twin Cities installation.

The burning of sewage solids is considerably different than burning a standard fuel. A standard fuel is much more uniform in characteristics and has a much more predictable behavior — not so with sewage solids. Table 2 shows that an enormous quantity of water must be evaporated compared to a standard fuel. This moisture is a factor that is somewhat controllable on a long-time interval basis in the vacuum filtration process, but from the standpoint of a quick short-time adjustment it is a practical impossibility. Further, due to the

Table 4—Sludge Disposal Construction Costs*

Item No.	Item	Buffalo [4,12]	Cleveland [5,13]	Detroit [6]	Mpls.-St. Paul [7]
1.	Date of original construction	1939	1932-1936 W 1938 S†	1936-1940	1935-1938
2.	Date of principal additions	1951	1951 S	1955	1951-1956
3.	Original cost, conc., filt. and incin. inv. only	$ 630,600	$ 686,071 W 2,807,000 S†	$2,295,400	$1,343,367.88
4.	Cost of additions, conc., filt. and incin. inv. only	251,000	2,487,000 S	101,250	402,625.73
5.	Original cost: digestion inv. only Digestion Additions	414,807	1,091,000 S 2,019,102 S†	260,000	0
6.	Total	$1,296,407	$9,090,173	$2,656,650	$1,745,993.61
7.	Replacement cost of existing plant at EN-R Index of 700	Unknown	Unknown	Unknown	$4,820,000

* Total construction cost of digestion and gas handling equipment, concentration tanks, vacuum filtration equipment, incineration and ash handling equipment, including the buildings and all structures associated therewith.

† W and S refer to the Cleveland Westerly and Southerly plants, respectively.

TOP two hearths of eight-hearth incinerators, with flue breeching above.

volatile matter present in the sludge cake, and particularly in the scum, there is a tendency for flash-over or rapidly rising temperatures to occur at or near the ideal combustion ratios in the combustion zone after the bulk of the water has been evaporated. This condition is controllable by the addition of excess air, maintenance of uniform feed, and cyclic and rate control of feed, as well as point of introduction.

The apparatus necessary to eliminate unusual bumps in load or temperature in the incineration system includes continuously weighing scales with recording of the totalizer reading every 15 minutes and computation of the feed input to each incinerator unit for this period. It includes continuously recording oxygen analyzers for each incinerator unit (preferably of the magnetic gas principle type) with a good sampling system.

Also vital to the process are multiple-point continuous recording pyrometers, and uniform control of draft and/or preheated air. Laboratory analyses of the filter cake and a load limit chart are made available to the operators. From a cost standpoint, the operating cost of the laboratory assignable to the principal divisions as previously described, are approximately as follows:

I = 12%		
II = 0%		
III = 51%		
IV = 22%	} 37%	sludge disposal
V = 15%		
Total 100%		

In connection with multiple-hearth type incinerators, variable central shaft speeds are of value, as well as certain limiting temperature controls. In the Minneapolis-Saint Paul system, the temperatures are limited in the hot zones to approximately 1600°F to protect the rabble arms and the central shaft. The rabble teeth and rabble arms are a ferrous alloy containing 25% chromium and 12% nickel. This is approximately equivalent to stainless steel type 309. A glance at a metallurgical table shows this metal will "creep" substantially starting at temperature of 1700°F and above.

To check this factor and reduce arm drooping, a thermocouple was installed in a Hearth 4 (hot zone) rabble arm approximately 16 inches from the inside end. This is a point of high stress and a point of hot flame application. Results to date (since April 1956) show that this thermocouple at times reads higher than the furnace peripheral thermocouples by as much at 200°F.

Of further interest in this particular system is the fact that conduction, convection, and radiation measurements at an incinerator feed rate of 1.4 tons of combustible per hour show a heat loss to the room of about 266,800 Btu's per hour per incinerator unit. In summer, several times as much air will be required for room ventilation compared to the total amount of fresh air required for combustion and excess air for incineration control purposes.

The limits of the evaporation and burning cycle can be better understood from the following 24-hour practical experience observed at Minneapolis-Saint Paul.

Ranges of sludge cake input conditions (from 24-hour composite samples):

22.7% to 46.4% dry solids (Dec. 1956, June 1946)

35.5% to 83.2% combustible (dry basis) (May 1942, Feb. 1956).

Maximum and minimum heat input conditions observed were as follows:

31.5% solids with 75.0% combustible. (Dec. 1953) and

36.9% solids with 46.9% combustible (July 1944).

11,600 Btu/lb combustible in the cake.
9,300 Btu/lb combustible in the cake.

Maximum and minimum amounts of material burned per 24 hours in one incinerator (computed to an hourly basis):

45.8 tons combustible (Aug. 1942) = 1.91 tons/hr
16.2 tons combustible (Nov. 1943) = 0.675 tons/hr
78.5 tons dry solids (May 1942) = 3.27 tons/hr
15.3 tons dry solids (Jan. 1945) = 0.637 tons/hr
191.1 tons wet cake (Dec. 1956) = 7.96 tons/hr
51.9 tons wet cake (Jan. 1945) = 2.16 tons/hr

Maximum and minimum tons cake water evaporated per 24 hours in one incinerator:

146.8 tons water (Dec. 1956) = 6.11 tons/hr
45.9 tons water (June 1944) = 1.91 tons/hr

The maximum 24-hour system loads observed have been as follows (4 incinerators operating):

677.5 tons wet cake (May 1956) = 28.1 tons/hr (no chemicals used)
182.2 tons dry solids (May 1956) = 7.58 tons/hr (no chemicals used)
126.1 tons combustible (May 1956) = 5.25 tons/hr (no chemicals used)
510.2 tons water evap. (May 1956) = 21.2 tons/hr (no chemicals used)

It must be remembered that none of these loads necessarily occurred simultaneously unless specifically so stated. However, simultaneous loads up to the capacity figures delineated in Table 2 are practical.

Accurate means of dividing feed between incineration units require belt system take-off blades, sludge cake levelers, shredders, or other means of segregating feed in order to obtain maximum capacity and flexibility of the incineration system. There are other factors, such as the ash disposal system, which affect cost of operation; but they are not as critical.

It must be kept in mind that the incinerator process must be considered as a system and the various components analyzed from the standpoint of their effect on the whole, in terms of operation and total cost.

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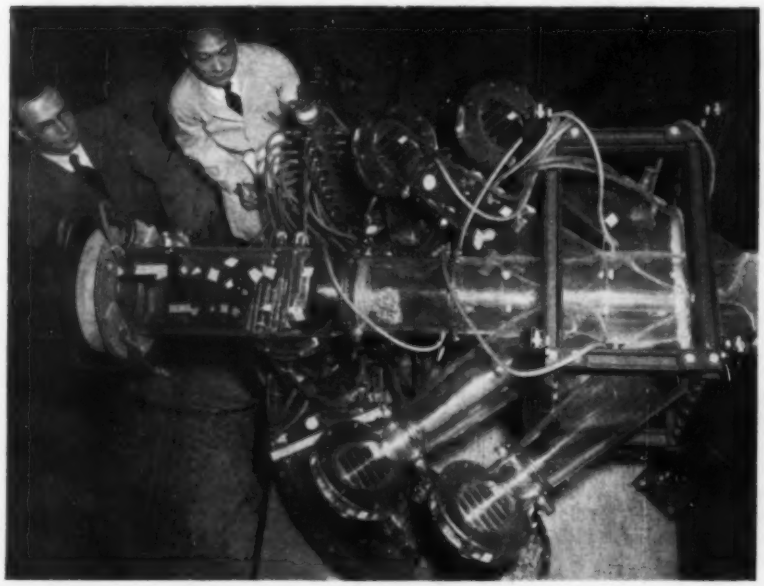
Confetti and Plastics Aid Pump Station Design

Confetti blown through a transparent plastic model has enabled civil engineers at the University of Michigan to minimize water turbulence and to reduce operating costs on a $6,000,000 water pumping station which the City of Detroit will soon construct.

The confetti is carried through the tubing on a stream of air simulating the flow of water through a pumping station as indicated in the photograph. By studying the paper streams through the optically clear tubing, th University engineers were able to detect turbulence which in normal operations would cause pumps to handle less than their designed load and which would cause excessive pump vibration and pitting of the pump impellers.

Some 46 design changes were made in the course of the model study, with a combined result of cutting energy losses in half. This will enable a savings of more $100,000 in projected operating and construction costs.

The cast acrylic plastic tubing in diameters up to 18 in. was manufactured by the Cadillac Plastic and Chemical Co.



ASCE Installs New Officers

L. R. Howson, Pres.; S. B. Morris and W. G. Bowman, Vice Presidents

At the annual meeting of the Amer. Soc. Civ. Engrs. in New York City on Oct. 16, Louis R. Howson, Cons. Engr. of Chicago, was installed as President for one year; he succeeded Mason G. Lockwood of Houston, Tex. Two Vice-Presidents and six Directors, also newly elected, took office. The Vice-Presidents are Waldo G. Bowman, of New York, Editor of *Engineering News-Record*, and Samuel B. Morris, of Los Angeles, former General Manager of the City of Los Angeles Department of Water and Power and a consulting engineer. They will serve two years.

The new Directors, elected for three years, will be Prof. Weston S. Evans, Orono, Me., Head of the Department of Civil Engineering, University of Maine; Craig P. Hazelet, Louisville, Ky., partner in Hazelet and Erdal; Donald H. Mattern, Knoxville, Tenn., Chief, Project Planning Branch, TVA; John E. Rinne, San Francisco, Engineer, Standard Oil Co. of California; Philip C. Rutledge, of New York, partner in Moran, Proctor, Mueser and Rutledge; Tilton E. Shelburne, Charlottesville, Director, Virginia Council of Highway Investigation and Research.

EXPERIMENTAL infiltration pits use chlorinated Illinois River water to recharge lowered ground water table.

Recharge of Ground Water At Peoria, Illinois

Findings from six years of study and experimentation

by T. E. LARSON, MAX SUTER and ORVILLE VOGEL

Respectively, Head Chemistry Subdivision; Head, Peoria Laboratory Subdivision; and Associate Chemist Illinois State Water Survey, Urbana, Illinois.

FROM 1940 to 1950, the Illinois State Water Survey with the cooperation of the Illinois State Geological Survey made a concentrated study of the water resources, their use and development in the Peoria area. The various sources of water were determined and recorded with respect to available quantity and quality.

Although the area under study included parts of five counties, the industrial area of Peoria, adjacent to the Illinois River, was of particular interest and attention. In this area concentrated industrial developments obtain water from a highly productive glacial outwash deposit.

The river bottom at this point and in Lake Peoria, above, is heavily silted and does not permit natural infiltration. Natural recharge of river water, therefore, is limited to flood stage periods and represents only a minor contribution to the ground water in this immediate area.

About 43 to 50 million gallons of water are pumped daily from glacial till and alluvium within this and the surrounding area of about 12.4 square miles, and particularly from coarse outwash deposits underlying the industrial area. Because this rate of pumpage is about 8 to 10 mgd in excess of the natural recharge, a gradual lowering of the water level has resulted.

Many wells have gone dry and in some areas only 10 feet of saturated aquifer remain, although where bedrock is not as close to the ground surface, 30 feet of saturation is present and water levels are in general 25 feet below the pool level of the Illinois River. Although industry has voluntarily reduced its pumpage by about 15 mgd since 1945, municipal pumpage has increased by 13 mgd.

The major dependable supplemental source of water in the area is the Illinois River (minimum flow, 2,300 sec-ft). Although this river was devoid of game fish about 30 to 40 years ago, improvements have been made in the past 20 years so that now the dissolved oxygen content at Peoria is rarely less than 5 ppm. Because the available areas for recharge are small and represent high-priced real estate, replenishment of ground water supplies using the river water source was considered favorable only if it could be done at high rates, in a small area.

To meet the objective of obtaining

experimental records and data, the State of Illinois appropriated funds in 1947 for the construction of a small experimental infiltration pit. The local industrial and municipal interests contributed $70,000 in order that a larger research-demonstration pit could be constructed which would recharge 2 mgd over the six months' period when the river temperature was less than 60°F. The operation, however, is still in experimental pilot plant. The time and temperature limitations were placed on the operation due to a need for maintaining cool temperature of the ground water.

The program was not planned to clarify or treat the river water in any way except by chlorination. Records showed the river water to have a turbidity less than 100 ppm for 300 days per year and a normal bacterial count of 26,000 per ml.

Test drilling at a site just north of Cedar Street bridge and adjacent to the river indicated the gravel deposit to contain only 2.1 per cent passing a 200-mesh screen, and estimated to provide a recharge of 15 to 20 mgd per acre.

A series of tests by Hiram Walker and Sons in 1941 in which the Water Survey cooperated, using an abandoned gravel pit on the property of the former, showed that 1,400 gpm could be recharged at a rate of 37 mgd per acre. The gravel was clean, with less than 0.5 percent passing a 200-mesh screen.

Design of Pit

With this guide, the design of the pit called for a 40 x 62½-foot bottom at an elevation of 430 MSL, or 10 feet below the pool stage of the Illinois River and 10 to 12 feet above the ground water level. The area at 440 feet elevation is about one-seventh of an acre.

The intake of sheet piling with a coarse screen permits river water to flow by gravity through a 16-inch pipeline to a control tower for chlorination, measurment of flow rate, and additional screening by fine screens. The rate of flow is governed by the infiltration capacity of the pit, the head loss through the structures, and the river stage.

Recharge results are recorded at 14 wells surrounding the pit at distances of 90 to 3,700 feet. Nine industrial wells provide additional data on water levels, temperatures, and chemical composition.

At the river, the control tower, and the pit, hourly records are maintained on water levels, temperatures and

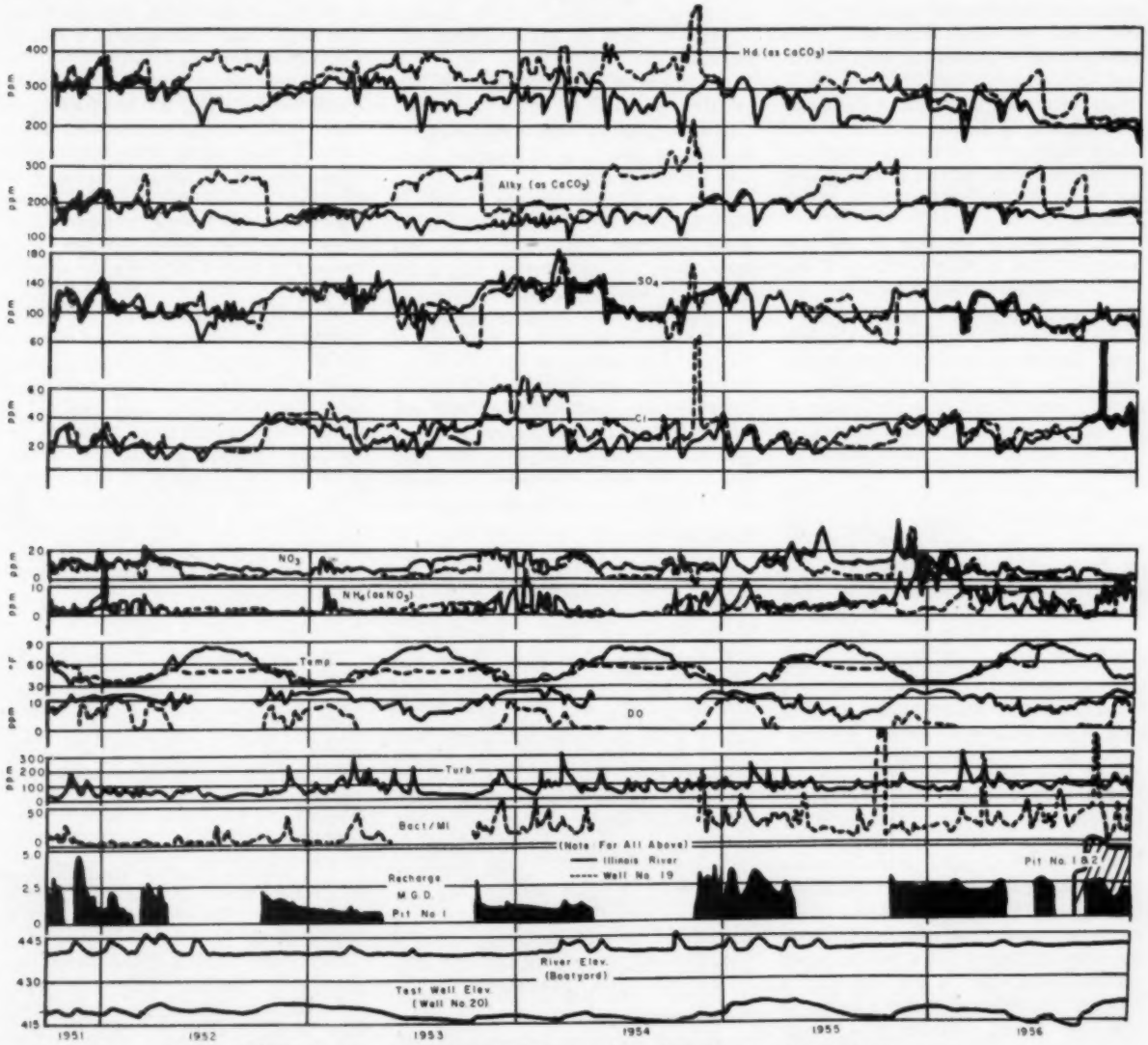


Fig. 1—RESULTS for six years of experimental operation of Peoria ground water recharge pits.

chlorination. Weekly records of temperature at various depths are obtained at the 14 recorder wells. Chemical tests are made daily on the river water and at a well 90 feet from the pit. Bacteriological tests are made four times per week.

The pit was cleaned and resanded each fall before starting seasonal operation.

Recent Developments

During 1956 two additional changes were introduced into the study. The dry summer of 1956 resulted in serious shortages in ground water. Because one nearby plant which demanded low-temperature water was forced to shut down for the summer, recharge was permitted during a one-month period when the river temperature was above the desired maximum of 60°F to study thermal effect. It was found that the rate of travel of this warm water to the pumping wells was 2,000 feet in 21 days and 3,000 feet in 42 days, increasing in temperature from the normal 50°F to 56°F when recharging at a rate of 2.26 mgd for a period of 29 days. This rate of travel for warm water approximates the rate for cold water, if allowances are made for the heat capacity of the ground.

Of particular interest is the observation that during recharge it has been determined that almost all the recharge takes place through the sides of the pit rather than through the bottom. Temperature-depth data at the observation wells indicate that the recharge water (cold or warm) spreads on top of the water in the ground aquifer, even as far away as 4,000 feet.

The second change concerns the construction of a second 1/7-acre pit adjacent to the first for the purpose of studying the interference and appropriate spacing of two units. The second pit has a bottom elevation at 335 feet MSL, or 5 feet below pool level and 15 to 17 feet above the ground water level. The results of the 1956-7 winter operations indicate that there is practically no interference between these two pits, at a 3-mgd rate into pit No. 2.

The results of six years of operation are summarized in Figure 1.

Filter Material

During the first three years of operation (1952-1954) a 6-inch layer of 1-mm sand lined the bottom and the sides of the pit. This sand clogged considerably, due to the silt in the river water reducing inflow, and even with the design and use of a swimming pool vacuum cleaner only about 1 mgd could be infiltered through the 1/7-acre pit.

In the fall of 1954, the pit was lined with 6 inches of 5- to 9-mm (3/16-in.) pea gravel as a filtering material. This permitted a recharge rate of 3 mgd, or about 22 mgd per acre. The reduction of flow due to silt during this season was only 12.5 percent, compared with 60 percent with sand.

Examination at the end of the season showed a build-up of silt to a thickness of 1 to 2 inches on top of the gravel, with a penetration limited primarily to the top 2 inches of the gravel. The gravel was determined to hold a maximum of 20 grams of silt (dry weight) per 100 ml. Actually, the upper 2 inches were found to contain 16 grams, whereas the the lower 2 inches contained only 6.8 grams per 100 ml.

Although 8.8 ppm chlorine was applied during the first three years of operation, subsequent tests showed 3 ppm to provide good quality infiltration.

At times of algae growths in the pit the use of 5 to 10 lb of copper citrate or copper sulfate per day restored the filter to its normal flow rate within 10 days.

Data on quality changes at well 19 are compared with similar data for the Illinois River. This well is 53 feet deep, with a 5-foot screen, and is located 160 feet from the waterline in the pit. The well samples were collected after 60 minutes of pumping at 25 gpm. Depending on the rate of infiltration, a 3- to 8-day lag was experienced before river water reached well 19. With this contact period chlorine was not normally found at the well. No *E. coli* were confirmed from the 24- or 48-hour presumptive positives.

Turbidity

For the experimental recharge operation, it was first decided to use Illinois River water of 60° F. or lower temperature and with a turbidity of not more than 100 ppm. After one year of operation the turbidity limits were removed, because it was found that periods of high turbidity were of only a few days duration and did not decrease the infiltration rate to an appreciable extent, particularly after vacuum cleaning was practiced periodically. Early experience in cleaning by scraping during a shutdown indicated that during freezing weather the out-of-service period may last longer than the period of high turbidity, because the filter bed may freeze and effectively prevent further infiltration.

Dissolved Oxygen

At the beginning of each infiltration period the appearance of dissolved oxygen in the well water lagged as much as three weeks behind the evidence of river water at the well as determined by mineral changes. It appears that oxidizable material, which uses up the dissolved oxygen, is present in the soil at the pit or in the pit area. The dissolved oxygen at the well, at no time increased to the amount found in the river water flowing into the pit. The loss of dissolved oxygen, the difference between that of river water and well water, was affected by the rate of inflow (retention time to well) and by the temperature of the water, which governed bacterial oxidation rates.

Minerals

Neither the river water nor the well water is of constant mineral quality. The quality of the former varies, as does that for any river, and is affected to a minor extent by an average diversion from Lake Michigan at a rate of 1,500 sec-ft per day.

The well water quality is normally somewhat variable, due to blending of water from various sources—as direct natural infiltration from rainfall, a small amount of natural recharge at the river banks particularly during high stage, and leakage of highly mineralized bedrock water through faulty casings in deep rock wells in the near vicinity.

As will be noted during off-season sampling, there are periods of low water level when the well water is characterized by the virtual absence of sulfate. Such water has been established to be stored water from a glacial deposit of Illinoian glacial age or earlier*. It also is typical of water from what is called the Sankoty sand, located on top of the bedrock and subsequently covered by the Illinoian glacial deposit and, later, the Wisconsin glacial deposit.

Sulfates

During recharge the sulfate content of the test well water is, in general, slightly less than that of the Illinois River. The best correlation occurred during the 1954-5 and 1955-6 infiltration periods, due to the rapid rate of inflow.

Chlorides

The normal chloride concentration in ground water is less than that in river water. The chlorides of well 19 appeared to be slightly higher than those of the Illinois River during the infiltration period. The well water chloride increases during the infiltration period due to the decomposition of chlorine by the chlorine demand of

the river water. However, the sum of the control tower is not always equal to the chlorine content found in the well water during recharge. The best correlation between the river and the well chlorides was experienced during the 1954-5 and 1955-6 seasons, possibly due to the higher rate of inflow than experienced during the previous two seasons, and to the lower rate of chlorination.

Other factors that may influence the amount of chloride found in the well are the possible use of sodium chloride on streets for snow and ice removal, or the use of calcium chloride for control of dust. Several periods of exceptional chloride concentrations in the well water cannot be reconciled due to lack of supplementary data.

Alkalinity and Hardness

The normal alkalinity and hardness of the well water are, respectively, about 100 to 140 ppm greater than that of the Illinois River. During recharge both parallel that of the river water.

Manganese and Iron

Prior to starting the recharge operation manganese was found in the well water to the extent of 0.3 ppm, but disappeared with the appearance of dissolved oxygen. It is evidently oxidized and precipitated from the water in the gravel strata through which it flows.

Iron was also found in the well water, before infiltration started, to the extent of 0.1 ppm, but disappeared with the appearance of dissolved oxygen. Iron and manganese do not reappear in the well water until approximately three months after shutdown.

Nitrates

Nitrate was present in the river and well water. During the first three seasons of operation, the water samples were analyzed after two to three weeks of storage at room temperature. This caused abnormal high nitrate data, due to the conversion of ammonia to nitrites and nitrates by bacteria during storage; therefore, these data are not considered reliable.

During the 1954-5 infiltration season, daily analyses provided more reliable data.

Survey Work Stimulates Others to Construct Pits

The success of this experimental pit has stimulated the construction of two other pits in the Peoria area by private industry. One pit recharges 1/35 acre at a rate of 60 mgd per acre with no more than a 5-foot depth of water in the 30-foot depth of pit. This pit is lined with pea gravel. The other pit, owned by the local water company, is 2 acres in size and is lined with 1-mm sand. No satisfactory evaluation has been made as yet, as its operation is irregular. The intake is unfortunately located at a point in the river where considerable paper fiber is present. This fiber seriously clogs the sand.

This experimental work is felt to be successful and significant, judging by the high rate of recharge. The effective use of coarse gravel is unique and the design to enhance lateral rather than vertical recharge is important. These principals are basic and available for other needs at other locations of judicious application.

Reference

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Large Manufacturing Plant Depends Upon Lagooned Rain Water

The Flick-Reedy Corporation is building a metal fabricating plant about 15 miles north-west of the Chicago loop district near the town of Bensenville, Ill.

The entire water requirement for manufacturing is to be supplied from lagoons which will store rain water falling on the 10 acres of roof and paved parking areas 5 acres each.

Two lagoons, each 600 ft. long by 75 ft. wide and 5 ft. deep will store 3,600,000 gallons of rain water. It is calculated that each inch of rainfall will result in 280,000 gals. of water input to the lagoons.

Water used for the "clean" operations such as cooling, heat treating, etc. will be returned directly to the lagoons. Water used in other operations will be returned to the lagoons after treatment in a package type Yeoman's aerator plant, similar to those used in small sewage treatment plants.

The small quantity of water needed for drinking and other personnel uses will be supplied by a deep well on the property. The sanitary sewage will be given complete treatment and the plant effluent will be added to the industrial supply lagoons.

In this day of water supply problems this method of providing a self-contained supply of soft water has interesting possibilities.

Important Test Case Won by Water Pollution Control Board

Of considerable interest is the recent decision handed down by the State Supreme Court of New York on an appeal by the town and village of Waterford from the C classification assigned to the waters of the Mohawk River by the N. Y. Water Pollution Control Board. A result of the assignment of the C classification will be to require the construction of sewage treatment facilities by several communities. In its unanimous decision the Court denied the contention of Waterford that enforcement of the C classification would contravene the public interest by imposing an increased tax burden and that the public hearing held in connection with the assignment of the classification was inadequate in that witnesses were not sworn, testimony taken, opportunity for cross-examination given and findings of fact made. As an important test case, Waterford's appeal had been watched with widespread interest by other New York municipalities and pollution control agencies throughout the country.

Fluoride Metabolism Facts

Data, Hitherto Unreported

The Institute of Industrial Health, College of Medicine, University of Cincinnati, announces a three-day "Symposium on Fluorides" to be presented December 9-11, 1957 inclusive. The purpose of this symposium will be to present the most recent information that is available concerning the physiological behavior of the absorption of fluoride.

Discussions will include a brief review of what is known of fluoride metabolism and a considerable amount of data hitherto unreported. The objectives of the symposium are to bring together and to present factual and scientific information on this subject to those who are working in the field of fluoride absorption.

The symposium will be open to physicians and dentists in industry and public health and to other professional persons who are interested in the subject. Attendance will be limited and early application is suggested. The registration fee will be $50.

For further information and application blank write to Secretary, Institute of Industrial Health, Kettering Laboratory, Eden and Bethesda Avenues, Cincinnati 19, Ohio.

Photometric Determination of Color and Turbidity of Water

With proposed new standard definitions

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Chief Chemist
Newcastle-Gateshead Water Co.
Newcastle upon Tyne, England

ALTHOUGH THE NEED for an approach more fundamental than the empiricism of the Hazen and Jackson methods has certainly been appreciated by some workers, there appears, nevertheless, to have been little progress in standard methods of defining and determining color and turbidity of water. Most suggestions have met with a discouraging lack of response.

In the determination of turbidity, recognition must, of course, be paid to the undoubted progress in the development of suitable photoelectric apparatus. Despite all this, however, the candle turbidimeter remains the standard instrument.

The principles of photometric methods have been studied by Knight[1] whose work is noteworthy in that it led to new proposals for standard turbidity units based on light extinction values. He also demonstrated[2] how the color of turbid waters could be estimated by photometric means without need for clarification of sample by filtering or centrifuging. The basis of attempts to determine simultaneously both color and turbidity rests on their differing absorbtion characteristics in different spectral regions.

In the past the application of such methods to the examination of natural waters has met with only limited success. It has not, perhaps, been fully appreciated that Hazen color standards, no matter how satisfactory for visual color matching, are unsuitable for use as photometric standards because the natural colors have light absorption curves differing from the artificial standards.

Another source of difficulty lies in the fact that the suspended matters of natural waters are not always of identical absorptiometric behavior. It is also desirable in standardizing turbidity measurement on the basis of optical densities to restrict the incident light to a fairly narrow range of wavelength. This need arises because the optical density of suspensions depends, although to a lesser extent than does that of color, on the wavelength of the incident light.

The aim of the author in the present work has been first to place the photometric methods on a satisfactory footing, and second to set up standard definitions for color and turbidity on a precise fundamental basis.

In doing this it is first to be noted that absorption of light by natural color and turbidity takes place in sufficiently close conformity with the Beer-Lambert laws. The optcial density is defined thus:

$$\text{Optical density} = \log_{10} \frac{\text{Incident light}}{\text{Transmitted light}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The total density of a number of layers is equal to the sum of the individual densities, so that

$$\text{Optical density per cm} = \frac{1}{D} \log_{10} \times \frac{\text{Incident light}}{\text{Transmitted light}} \quad \ldots\ldots\ldots\ldots (2)$$

in which D is the depth of the solution, in centimeters.

Determination of Turbidity

The definition of turbidity here put forward is based on an original suggestion by Aitken and Mercer[3] in which T is turbidity, E is the extinction value, and D is the cell depth in cm.

$$T = \frac{10^3 E}{D} \quad \ldots\ldots\ldots\ldots (3)$$

For absolute precision it is necessary also to define the wavelength of the incident light, as this affects the optical density. It is now proposed that the standard light source should be yellow, with a peak wavelength of 580 mμ, as given, for instance, by an Ilford narrow-band spectrum filter No. 606.

The proposed standard definition of turbidity may now be restated as follows:

The unit of turbidity is to be taken as that of a suspension having an optical density of 0.001 *per cm depth to yellow light of peak wavelength* 580 mμ.

For routine turbidity measurement normal artifical light should give figures not significantly different from those obtained with the standard illumination. The new unit may be termed the A.T.U. (Absorptiometric Turbidity Unit).

In adopting a fundamental unit for turbidity at this time it is desirable, for the sake of continuity, that the new scale should bear a reasonably close relation to existing A.P.H.A. standards[4]. Consideration may now be given, therefore to a comparison of the two scales. In the present standard procedure for making observations with the candle turbidimeter, the following instruction appears: "After the image has been made to disappear, the removal of 1 percent of the sample should again make the flame image visible." It is reasonable to assume from this that determinations with the standard candle involve percentage transmissions very closely approaching but not quite zero.

Let it be assumed, for the sake of argument, that the actual value for absorption is 99.3 percent.

Then, from Eq. 1,

$$E = \log_{10} \frac{100}{0.7} = 2.155.$$

If, for example, the suspension able to obscure the standard candle in a depth of 21.5 cm is now considered, it will be seen to have a turbidity of 100 on the A.P.H.A. scale. Suppose its value in terms of A.T.U's. is X.

From the proposed definition

$$\text{(Eq. 3)}, X = \frac{10^3 \times 2.155}{21.5} = 100.2$$

Thus, the value in A.T.U's. is seen to be practically identical with the A.P.H.A. value of 100.

Taking the same percentage absorption value to apply throughout the range given in Standard Methods [4] the following table may be constructed:

Light Path, cm	Turbidity A.P.H.A.	Turbidity, A.T.U's.
2.3	1,000	930
4.5	500	480
8.7	250	250
14.4	150	150
21.5	100	100
39.8	50	54
72.9	25	29

The differences between the two scales are clearly without significance, being well within the experimental errors of the candle turbidimeter. By way of further confirmation, reference may be made to the optical densities obtained by Hoather[5] for two A.P.H.A. fuller's earth suspensions of 25 and 75 ppm. These suspensions had been standardized by the Jackson candle turbidimeter and it is estimated from Hoather's results that their optical densities for a wavelength of 580 mμ and a cell depth of 4 cm were 0.11 and 0.31, respectively. From these values the corresponding turbidities in A.T.U's. would be 28 and 78.

Determination of Color

The standard Hazen solution, as already pointed out, is not suitable for the calibration of photoelectric absorptiometers to be used for measuring the color of natural waters. The preferred method of calibration, therefore, is to prepare a range of standards from natural waters, paper-filtered several times until perfectly clear, of which the actual color values are obtained by visual matching against Hazen standards.

For maximum sensitivity the incident light should, of course, have a color complementary to the yellow-browns of natural waters; this color, therefore, will be towards the violet end of the spectrum.

It has to be noted, nevertheless, that this method of calibration is not entirely free from error because, for instance, the colors of natural waters can differ in spectral composition. As with turbidity, there is a need for an approach to a fundamental standard and the following definition, analogous to that of turbidity, is proposed:

The unit of color is to be taken as that of a clear water having an optical density of 0.001 *per cm depth to violet light of peak wavelength* 425 *mμ.*

The yellow-brown colors usually encountered in natural waters should show maximum absorbance with incident light of this wavelength range. In other cases, it would be permissible to modify the standard definition by using light peaking at such other wavelength as gives maximum absorbance for the given sample, subject to an appropriate note accompanying the photometric results.

The new unit may be referred to as the A.C.U. (Absorptiometric Color Unit). From many determinations on natural waters it has been established that color readings in A.C.U's. may be converted to degrees Hazen by multiplying by 2.5. That the new unit is 2.5 times larger than the Hazen unit is not without advantage; the latter is inconveniently small for practical use.

It is suggested that in practice one might classify waters of A.T.U's and A.C.U's each less than 5 as "satisfactory," and between 5 and 10 as "moderately satisfactory" so far as their physical appearance is concerned.

Differential Determination of Color and Turbidity

The possibility of determining both the color and the turbidity of a given sample by the simple operation of determining its optical densities with two different light filters is very attractive, not least because of the saving in time where many samples are to be examined.

Expressing colors and turbidities in absorptiometric units frees the apparatus from calibration troubles. A complication arises, however, in that the color reading must be corrected for the effect of any turbidity present, and the turbidity reading for the effect of color. To apply the appropriate corrections it is necessary to determine the values of the ratio

$$\frac{\text{Optical density to violet light (Ilford filter 601)}}{\text{Optical density to yellow light (Ilford filter 606)}}$$

for both color and turbidity.

In the case of natural color the ratio was found to have a value of 4.7, so that 1/4.7 of the Filter 601 reading will appear with turbidity in the Filter 606 reading. Color readings with Filter 601 are to be similarly corrected for turbidity effects.

In the case of turbidity, however, the value of the foregoing ratio depends on the particle size of the suspension. A fine-suspension ratio of 1.6 was obtained using fuller's earth suspensions which had stood 24 hours. Relatively coarse suspensions of fuller's earth which had not been allowed to settle gave an average value of 1.2. By taking the differences of photometric readings before and after centrifuging several samples of natural waters an average value of 1.22 was obtained for the suspended matters so removed.

It would be inconvenient in correcting colors for the effect of turbidity to have to use different values for this ratio depending on whether the suspended matters appeared coarse or fine. Using the fine-suspension ratio and allowing all samples to stand 24 hours before determining colors would present one solution, but that procedure also is thought to be somewhat inconvenient. If the average value of 1.4 is used for all cases, waters containing matter in fine suspension will have their colors slightly undercorrected (that is, the readings will be slightly high); but as the actual degree of turbidity is usually low, as in filtered waters, for instance, no significant errors are involved. Raw waters containing coarser suspended matter will have their colors a little overcorrected, but in such cases small errors in color determination are usually unimportant. This question has been reconsidered, however, in the light of more than two years of experience in applying the methods to daily control testing at a large waterworks and, on balance, it is thought better to undercorrect filtered water colors, because the corrections involved are so small anyway, rather than overcorrect raw waters. For that reason the turbidity ratio of 1.2 is now used for all cases.

Using the value of 4.7 in the case of color and 1.2 in the case of turbidity, it is now possible to construct a simple nomogram so that the two optical density readings obtained on a given sample may be converted immediately into corrected colors and turbidities.

Nomograph Aids Solution

The author uses an apparatus having 10-cm cells and a scale calibrated in optical densities x 100. For convenience, the nomogram has scales calibrated to suit this particular instrument and cell depth; that is, in terms of optical densities per cm x 1,000, as in the nomogram presented in Figure 1.

The construction of the nomogram may be followed from Figure 2. The two optical density scales are first drawn, preferably on graph paper, to a convenient length (say 25 cm) and a convenient distance apart (say 15 to 20 cm). The upper limits are arbitrarily chosen, but values of the order of 24 for the 601 scale and 12 for the 606 scale have been found satisfactory in enabling the lower colors and turbidities to be read off the nomogram with accuracy. If either one or both readings do not fall within the scales, both readings are divided by 2 or other suitable factor and the appropriate correction is then applied to the

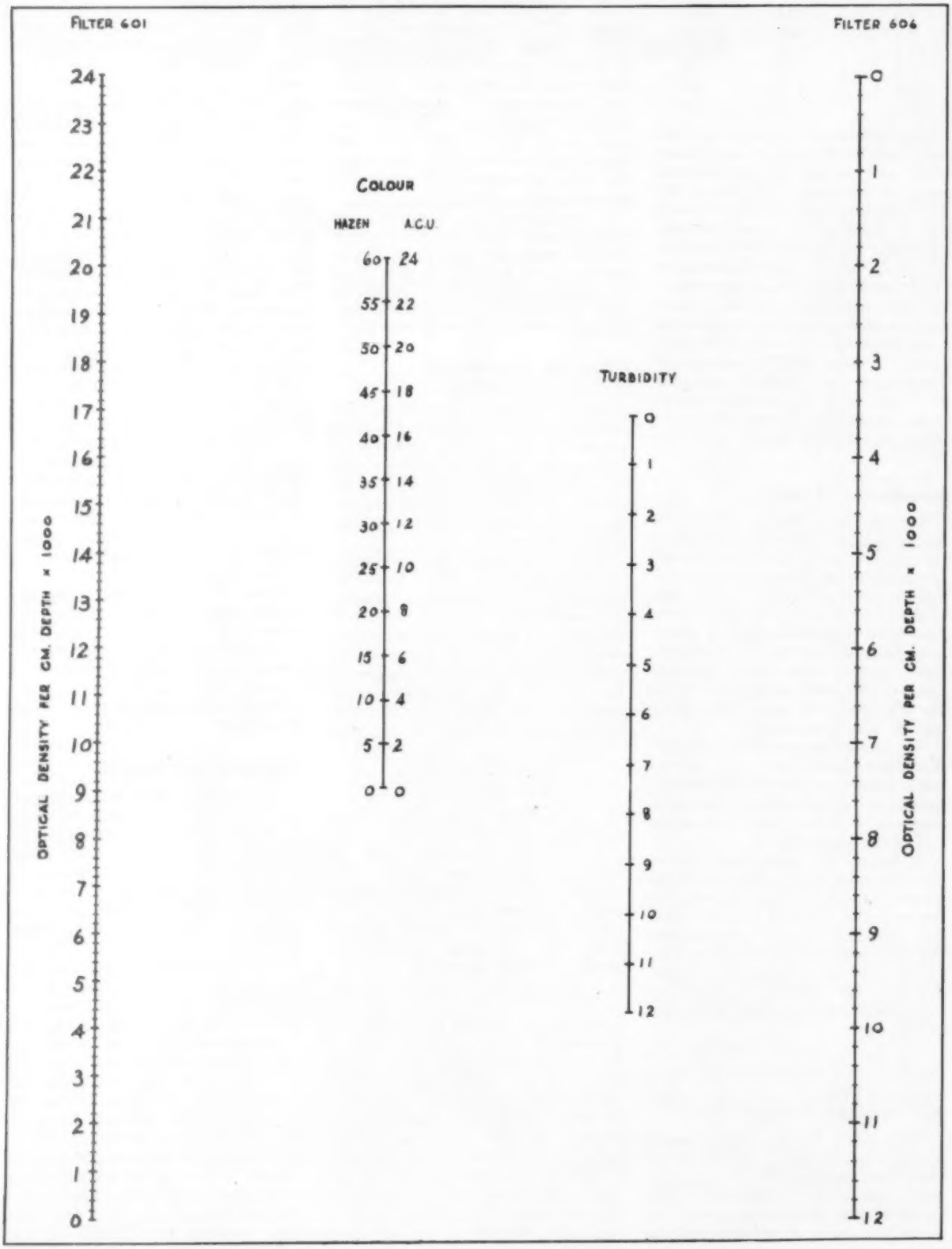

Fig. 1.—NOMOGRAM for photometric determination of color and turbidity.

color and turbidity readings given by the nomogram.

In fixing the position of the color and turbidity scales, which are to lie between the optical density scales, it is first to be noted that the zeros of these scales will lie on the line joining the optical density scale zeros.

Taking the maximum reading of 24 on the optical density scale with Filter 601, if this is entirely due to color the corresponding Filter 606 reading will be $\frac{24}{4.7} = 5.1$. Line AB may now be drawn and, because this line also corresponds to zero turbidity, the intersection at point X fixes the zero of the turbidity scale. The maximum of the turbidity scale is obtained by assuming that the Filter 606 reading of 12 is entirely due to turbidity, thus giving a corresponding Filter 601 reading of $12 \times 1.2 = 14.4$. Line CD may now be drawn. The turbidity scale is next drawn in as shown, parallel to the other scales, and is subdivided into units by pivoting a straight-edge on Y and setting against optical density readings on Filter 606 scale.

Point Y is also the zero of the color scale, which is drawn in as shown and suitably subdivided by pivoting a straight-edge on point X against the Filter 601 scale. The color scale, if desired, may also be calibrated in Hazen units using the conversion factor 2.5 previously given.

The nomogram shown in Figure 1 may be used with any water and with any apparatus suitable for measuring

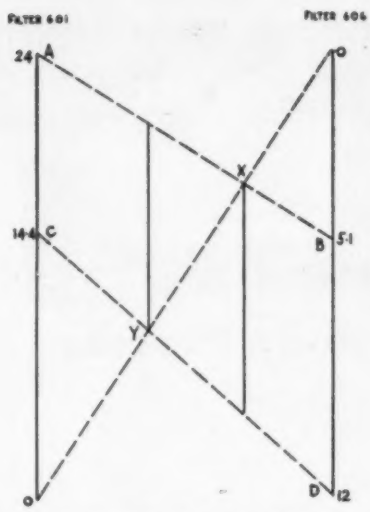

Fig. 2.—METHOD of constructing nomogram of Figure 1.

optical densities in the prescribed way.

It is pointed out, however, that the value of the ratio of optical densities for color will depend to some extent on the nature of the impurities causing the color, so that its determination should strictly by made using natural colors of the type most likely to be encountered in practice. Any variation in this ratio would affect the amount by which turbidity readings with Filter 606 require correcting for color; it would not, of course, influence in any way the method of defining standard color.

The turbidity ratios also could be determined for the type of water normally being examined by a preliminary examination of the differences in readings before and after centrifuging to remove the suspended matter. Again, the use of light filters having somewhat different characteristics from those specified might also necessitate the use of slightly different values for the optical density ratios.

The analyst, therefore, in constructing his nomogram may prefer to use his own experimentally determined values for these ratios in place of those given. It is considered, however, that use of the nomogram shown in Figure 1 will not introduce errors of any significance as long as any departure from the method as given is of no more than a minor nature.

For a more detailed study of these simple photometric methods for the determination or color and turbidity the reader is referred to the original paper[6].

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Water Resources Council for Clean Streams and Water Conservation

A new nationwide drive to conserve and improve the country's water supply was announced recently at an organizational meeting highlighted by a message of support from the President of the United States.

The campaign was outlined at a meeting in Harrisburg, Pa., of trustees of the Water Resources Council, Inc., an organization of 19 national associations representing civic, manufacturing, commercial, technical and conservationist groups.

Said President Eisenhower:

"The development of a national clean streams program is a step in the right direction. Water is one of our most critical resources and the pollution of our waterways is an extravagant waste. As our people are alerted to their responsibility in this vital area, and encouraged to accept strong voluntary controls originating in their local communities and states, I am sure the national health and economy can be strengthened. Congratulations to the Water Resources Council and best wishes for the success of their important work."

The Water Resources Council believes that pollution, besides being destructive of life and property, is "the nation's most extravagant waste of water."

It is the Water Resources Council's belief that pollution abatement is not so much a matter of needing stronger anti-pollution laws as it is one of winning and keeping the public's support for the laws we now have. To achieve this the Council proposes a state-by-state program for alerting the public to these needs.

Stimulated by the American Water Works Association, the Water Resources Council came into being last year on the initiative of the equipment manufacturers in the water and sewage field, who have also recognized the full import of what is being referred to as the "coming water crisis."

Today, the council includes some 19 associations, amongst which are the American Nature Assn., American Public Works Assn., American Recreation Soc., American Water Works Assn., Conf. of State Sanitary Engineers, Fed. of Sewage & Industrial Wastes Associations, General Federation of Women's Clubs, Izaak Walton League of America, National Wildlife Federation, and the Water & Sewage Works Mfrs. Assn., Inc.

The Council enjoys the blessings of the United States Public Health Service, the Mellon Institute for Industrial Research, and the Conservation Foundation, Inc. in addition to those of the President of the United States.

Water Softening

Part 2—The Lime-Soda Process

The forty-third of a series

Important Correction!!!
At the end of this installment there appears an important correction on "Protective Coatings," which appeared as Sect. G in Corrosion—Part II, published on pages 309-310 of the July 1957 issue of *Water & Sewage Works*.

by GEORGE E. SYMONS, Ph.D.

In this series, Dr. Symons discusses water works practices in the form of short school lectures, designed to assist operators, students, and others who may wish to review fundamentals in this field.

C . . . Lime-Soda Process

1 . . HISTORY

a. According to M. N. Baker, in his "Quest for Pure Water" published in 1948 by AWWA, several persons investigated the softening of water by alkaline salts long before the process was adopted.

(1) Among these early investigators were: Dr. Peter Shaw (1730), Dr. Francis Home (1756), Dr. John Rutly (1758), Henry Cavendish (1765), Thomas Henry (1781), Edmund Davey (1818), and Abraham Booth (1830).

(2) Some authors credit Thomas Henry with having first proposed, (in 1800) the use of lime for water softening on a plant scale; the idea was not adopted, however, for four decades.

b. Dr. Thomas Clark of Aberdeen, Scotland, in 1841, first used the process on a large scale and "patented the process by adding lime to water to precipitate earthy carbonates held in solution by carbonic acid."

c. Dr. Porter of London, in 1856, suggested the use of soda-ash for removing non-carbonate hardness and the lime-soda process was known as the Clark-Porter process for many years thereafter.

d. Growth of softening plants.

(1) The number of softening plants constructed between 1841 and 1893 is not known, but between 1893 and 1898, more than 50 softening plants were constructed in England.

(2) The first softening plant on this continent was built in 1901 at Winnipeg, Can., and the first plant in the United States was built at Oberlin, Ohio in 1903.

(3) Approximately 400 municipal water supplies are now softened by the lime or lime-soda process.

2 . . CHEMISTRY

a. The lime-soda softening process depends essentially on the insolubility of calcium carbonate and magnesium hydroxide.

(1) By adding lime — $Ca(OH)_2$ — and soda ash — Na_2CO_3 — to water under controlled conditions, it is possible to produce these insoluble compounds and the hardness is thereby reduced.

(2) Inasmuch as carbon dioxide, dissolved in water, will react with lime, this factor must be taken into account in the chemistry involved.

(3) Either lime — CaO — or hydrated lime — $Ca(OH)_2$ — may be used in the treatment, but the reactions are written for calcium hydroxide, since it is always formed in the slaking process where calcium oxide is used.

b. When only lime is used, the chemical reactions are:

(1) $CO_2 + H_2O \rightleftarrows H_2CO_3$

(2) $H_2CO_3 + Ca(OH)_2 \rightleftarrows Ca(HCO_3)_2 + H_2O$

(3) $Ca(HCO_3)_2 + Ca(OH)_2 \rightleftarrows$

(4) $Mg(HCO_3)_2 + Ca(OH)_2 \rightleftarrows MgCO_3 + CaCO_3 + 2\,H_2O$

(5) $MgCO_3 + Ca(OH)_2 \rightleftarrows Mg(OH)_2 + CaCO_3$

c. When lime and soda ash are used the chemical reactions are:

(1) $MgSO_4 + Ca(OH)_2 \rightleftarrows CaSO_4 + Mg(OH)_2$

(2) $CaSO_4 + Na_2CO_3 \rightleftarrows CaCO_3 + Na_2SO_4$

d. From these reactions it can be seen that:

(1) When only lime is used, only carbonate hardness is reduced.

(2) When lime and soda-ash are used, both carbonate and non-carbonate hardness are reduced.

(3) In equation b-(3), the calcium bicarbonate — $Ca(HCO_3)_2$ — can be that naturally present in the water or that produced by reactions in equations b-(1) and b-(2).

(4) In equation c-(2), the calcium sulfate — $CaSO_4$ — can be that naturally present in the water under treatment or that produced by reaction c-(1).

e. Other reactions involved in softening:

(1) The reaction of chlorides or nitrates of calcium or magnesium are

Ed. Note: Dr. Symons is Executive Vice President and Editorial Director of the Scranton Publishing Co., Inc.

the same as those in equations c-(1) and c-(2) for sulfates.

(2) If sodium carbonate is present in a water supply, it will react with lime, in sequence, after equation b-(3).

$$2\ NaHCO_3 + Ca(OH)_2 \rightleftarrows Na_2CO_3 + CaCO_3 + 2\ H_2O$$

. . . If sodium bicarbonate is present, there will be no non-carbonate hardness in the water.

f. Factors which affect the softening reaction include:

(1) Chemical equilibrium and mass action.

. . . While these reactions follow in sequence, as listed above, none of the reactions listed proceeds to completion before the next one starts; actually, there is overlapping in every case.

. . . The extent to which the softening reactions go to completion will depend on the excess concentration of the reagent. In the cold process an excess of lime is essential to force the reaction toward completion.

(2) Solubility of the end products of the reactions.

. . . The softening reaction can not be driven to reduce the hardness below the solubility of calcium carbonate (about 15 mg/L) and magnesium hydroxide (about 6 mg/L) at room temperatures.

(3) Temperature of the water.

. . . Both the speed of these reactions and the extent of completion vary directly with temperature changes.

. . . Laboratory studies by Thuma at St. Paul, Minn. showed the effect of temperature. (See Table 2)

(4) Presence of other ions.

. . . The type of anions present in the raw water has an effect on the rate at which insoluble calcium carbonate is formed.

. . . The sulfate ion has the greatest effect on slowing down the rate of formation of $CaCO_3$; the chloride ion has a lesser effect.

. . . The softening action proceeds fastest when only bicarbonate is present in the water.

(5) Presence of nuclei.

. . . In the presence of preformed precipitate or other nuclei, the rate of softening reaction is increased under all conditions of temperature and in the presence of anions other than bicarbonate.

(6) Formation of complex salts.

. . . Under some conditions, complex magnesium salts may be formed. These complex compounds are more soluble than magnesium hydroxide, and if formed, theoretical hardness reduction cannot be obtained.

. . . One theory proposes that basic magnesium carbonate — $Mg_4(OH)_2(CO_3)_2$ — may be formed; another theory suggests that the complex is a double salt of sodium, magnesium, and carbonates—$MgCO_3 \cdot NaHCO_3 \cdot 4H_2O$ — or $MgCO_3 \cdot Na_2CO_3$.

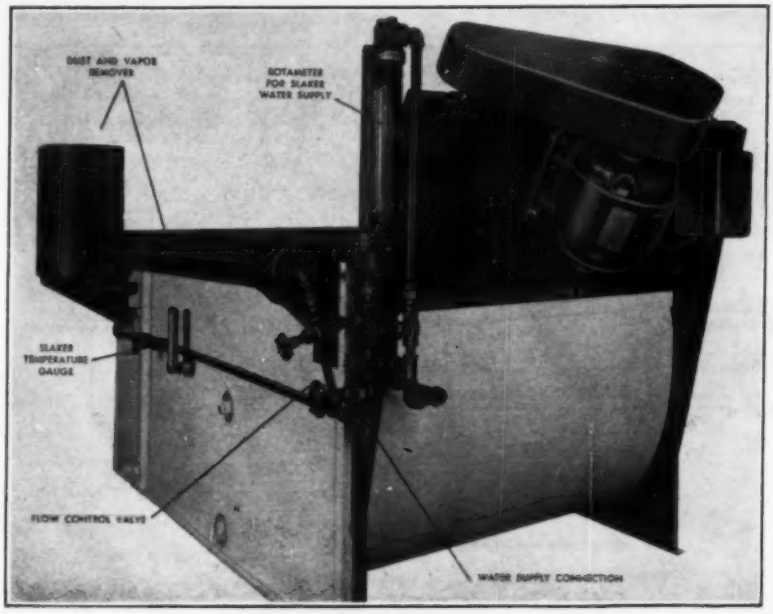


Fig. 2—LIME feeder and slaker at Richmond, Va. Capacity 250 lbs. per hr.

. . . Waters containing high non-carbonate hardness are more difficult to soften than those low in non-carbonate hardness, because the soda ash required tends to cause the formation of the basic carbonate complex salts.

(1) Colloid formation.

. . . Under some conditions, or combinations of several factors mentioned above (temperature, other ions, complex salt formation, etc.), the precipitated salt may tend to remain in colloidal form.

. . . Colloidal precipitates of this type may be present, only in low concentration, but their presence may either cause after precipitation in filters, or in distribution systems. While these colloids remain in the water, the hardness of the water will be increased by the equivalent amount of colloidal calcium carbonate present.

3 . . VARIATIONS

a. Theoretically, if the chemical reactions in softening followed the equations given heretofore, then the residual hardness of a water supply softened by the lime-soda process would be the sum of the solubility of calcium carbonate (15 mg/L) and magnesium hydroxide (6.4 mg/L).

(1) Conditions under which these solubilities can be obtained are seldom found in practice.

(2) Many factors, as outlined above, prevent the reactions from occurring as indicated or from going to completion.

(3) In practice, the residual hardness obtained as a result of softening, is usually 50 to 70 mg/L.

b. In order to obtain the lowest possible residual hardness in a softened water supply, one or more methods, aids, or variations of the process may be employed.

(1) Excess treatment, or the addition of excess lime, and soda-ash may be used to "drive" the reactions to completion.

. . . The method consists of adding an excess of lime (35 to 70 mg/L) above the calculated amount to precipitate the magnesium, followed by the addition of soda-ash to neutralize the excess lime and produce a caustic alkalinity. The amount of soda-ash required is that necessary to react with the non-carbonate hardness and the excess lime.

. . . Excess treatment has been more popular for railroad supplies; it will produce a residual hardness of approximately 35 mg/L.

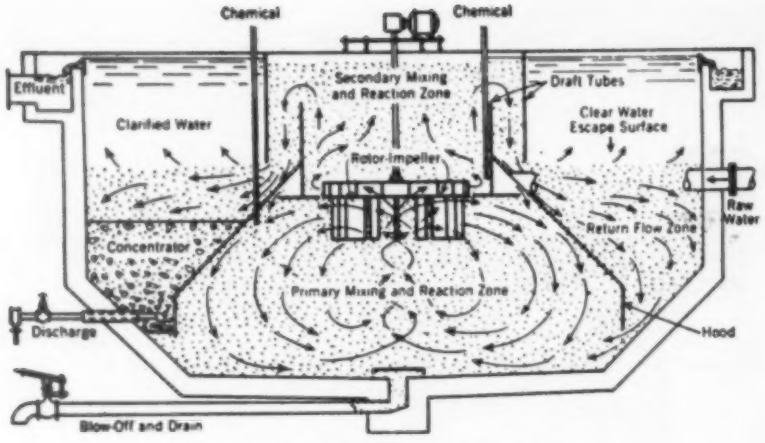
(2) Split treatment is a modification of the excess treatment.

TABLE 2

Residual Hardness Obtained at Different Temperatures

(Results in mg/L of $CaCO_3$)

Time Minutes	2°C	10°C	20°C
30	124	84	64
60	82	71	46
90	71	67	46
120	75	62	—



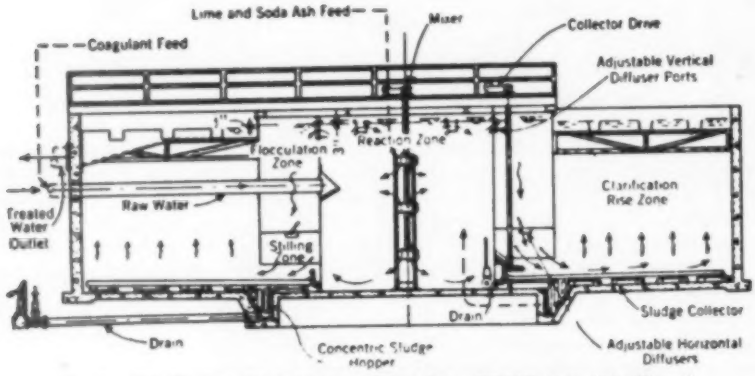


Fig. 3—ABOVE, The "Accelator," Infilco, Inc. BELOW, The "Clariflow," Walker Process Equipment Co.

(Diagrams from "Manual of Water Quality and Treatment" by permission of AWWA.)

. . . As large a portion as possible of the supply is treated with excess lime to obtain the lowest possible residual hardness; the excess lime in this portion of the water is then neutralized with untreated water.

. . . Split treatment effects a greater hardness reduction for a given amount of chemicals than does the addition of the chemicals in what might be termed the normal way.

. . . Split treatment automatically produces a water with a positive saturation index with respect to calcium carbonate but the water will be undersaturated with respect to magnesium hydroxide.

. . . Residual hardness obtained by split treatment will be above that obtained by "excess" treatment, and may be as high as that obtained by "normal" treatment, but the cost of treatment will be lower than either "excess" or "normal" treatment.

(3) Flocculation by mechanical means, without coagulating chemicals, aids in reducing the amount of colloidal precipitates and hence reduces the tendency toward after-precipitation.

(4) Coagulation with alum, sodium aluminate or activated silica reduces the amount of colloids, aids in the removal of precipitates by settling, and shortens the time required for settling.

(5) Removal of CO_2, not only reduces the lime requirement (See Eq. 1 in Sect. 2-b above) but it breaks down some of the bicarbonate and raises the pH slightly.

(6) Suspended solids contact, as may be obtained by the use of "upflow" or "suspended solids contact" clarifiers is a method of bringing the newly precipitated colloids in contact with preformed nuclei.

. . . This method has the advantage of not only providing solids-contact mixing, but also flocculation of colloids, solids-water separation, and continuous sludge removal.

. . . Less chemical dosage is required to produce the same results as "normal" treatment.

(7) Recarbonation after excess treatment will reduce carbonate hardness to approximately the solubility limits of calcium carbonate and magnesium hydroxide.

. . . Lime dosage is from 25 to 60 mg/L above that required to react with the free and half-bound carbon dioxide (i.e. 0.44 of the bicarbonate) and to precipitate magnesium.

. . . This excess treatment leaves a high pH and a supersaturated condition with respect to calcium carbonate. From such a water, calcium carbonate will precipitate on sand grains and in distribution systems.

. . . To reduce the supersaturated condition, after sedimentation of the precipitates, carbon dioxide gas is added to the water until the total alkalinity minus twice the phenolphthalein alkalinity equals approximately 5 mg/L. Recarbonation as this process is termed should proceed only to a pH of 9.4; if the pH is reduced to 8.3 the water tends to become corrosive.

. . . Recarbonation reduces the tendency of colloidal calcium carbonate and magnesium hydroxide to precipitate on filter sand grains. Some incrustation of sand grains does occur, however, and this of course, reduces the final residual hardness of the water.

. . . The need for and effect of recarbonation will vary with the treatment process, the particular water characteristics, method of flocculation and perhaps several other factors.

(8) Combination lime and ion-exchange softening is also practiced; this process will be covered more fully following the section on ion-exchange softening.

(9) Hot process softening is limited almost exclusively to the softening of boiler feed waters.

. . . The reaction is carried out near the boiling point of water. Since the speed of chemical reactions is nearly double for every 10 deg. C. increase in temperature, the softening reactions proceed more than 250 times as fast as at normal room temperatures.

. . . The precipitates from a hot process form in large flocs, are heavier and settle out more rapidly since the viscosity of the water is lower.—No coagulants are needed and no lime is required for dissolved carbon dioxide since it is driven off by heat.

. . . The solubility of the end products is very little different from that at low temperature, but the reaction proceeds more nearly to completion so that in the hot process the residual hardness (about 35 mg/L) is lower than can be obtained by the cold process.

4 . . EQUIPMENT

a. *Storage* of chemicals is important inasmuch as larger amounts of chemicals are required for water softening than for ordinary coagulation. It is necessary therefore to provide greater facilities for storage and handling of chemicals.

(1) Large quantities of both lime and soda-ash can be handled most economically if stored in bulk in hoppers located above the chemical feeder floor. Bulk chemicals may be unloaded from cars by pneumatic conveyors or power shovels.

(2) Bagged chemicals, if used, may be stored on the floor above the chemical feeder and dumped into the feeder hopper with or without a dust collector system.

. . . Some chemical feeders are equipped to allow dumping of bagged chemicals at the feeder floor level, with the chemical being elevated to feeder hopper level by mechanical devices. This system avoids the necessity for elevated storage.

. . . See the chapter on "Chemical Handling and Feeding" for more details.

b. *Chemical feeders* are required for the measurement and addition of lime and soda-ash, also for coagulants and stabilizing agents if any of these latter chemicals are used.

(1) Hydrated lime is fed by dry-feed machines, usually gravimetric, through a slurry tank. The slurry may be added to the water by gravity flow; if that is not possible, a diaphragm pump may be used.

(2) Quicklime is fed by a combination gravimetric dry-feed machine and slaker, which controls the addition of slaking water and temperature to produce a properly slaked lime free from grit. (See Fig. 2).

(3) Other chemicals (coagulants and stabilizers) are fed by feeders particularly suited to the chemical and may be dry-feed, solution feed, gas feed, or special device.

(4) The present state of development of dry chemical feeders has practically eliminated the use of chemical solution tanks and the difficulties attendant thereto.

(5) For a complete description of the various types of chemical feeding devices, see the chapter on "Chemical Handling and Feeding".

c. *Mixing* devices are essential, particularly to insure that the milk of lime slurry is completely dispersed throughout the water to be treated. (Saturated lime solution is no longer used because the relatively low solubility of the lime requires a very large volume of reagent solution.)

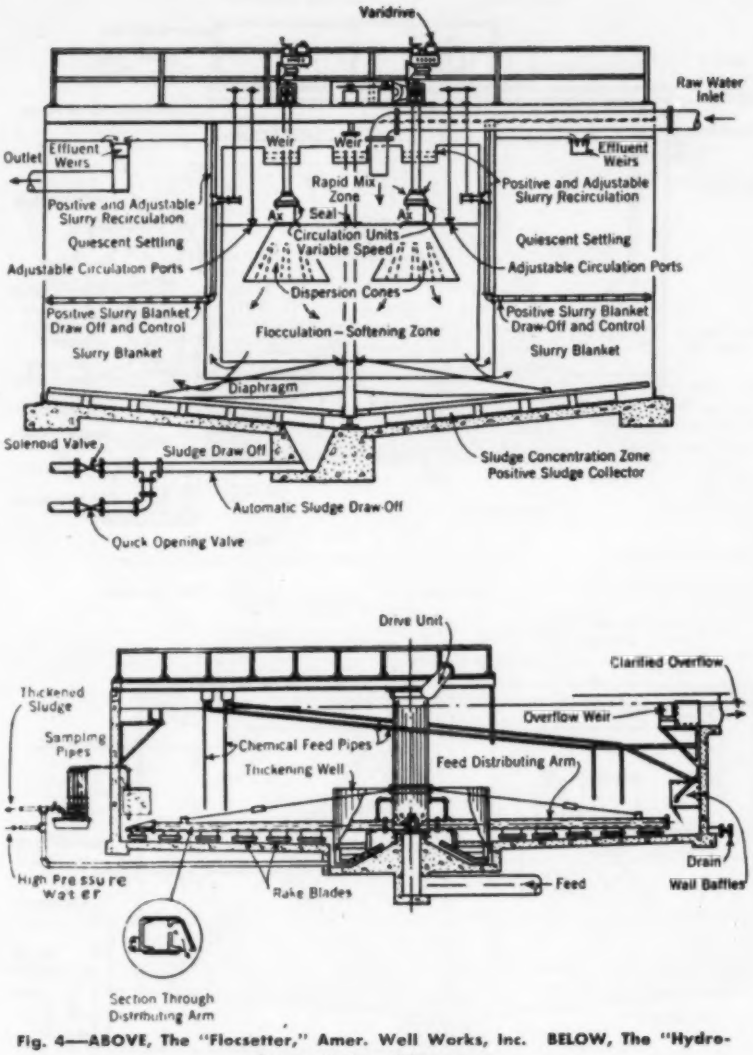


Fig. 4—ABOVE, The "Flocsetter," Amer. Well Works, Inc. BELOW, The "Hydro-Treater," Dorr-Oliver, Inc.

(Diagrams from "Manual of Water Quality and Treatment" by permission of AWWA.)

(1) Quick mixing is usually accomplish by high speed paddles, but other means of mechanical mixing may be used.

(2) Slow mixing and flocculation may utilize any of the several mechanical flocculators on the market. This process must provide the time necessary for the softening reaction to take place and the detention time is determined with due consideration for the seasonal temperature range of the water to be treated.

(3) For more details on mixing and flocculation equipment and its operation, see the chapter on "Mixing and Sedimentation".

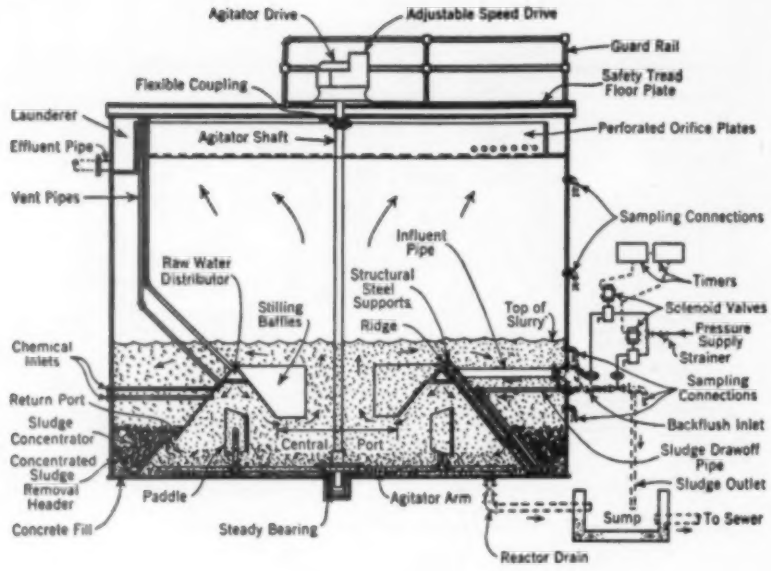
(4) In the up-flow clarifier or suspended solids contact softener, mixing of the chemicals is done by mechanical agitation in a zone designed for that purpose.

d. *Sedimentation* basins for water softening plants are designed to consider both the time required for settling and the volume of the sludge formed.

(1) As may be expected, more sludge is produced in water softening than from normal coagulation processes. For this reason, settling basins with mechanical devices for the continuous removal of sludge are generally used. These basins are usually termed "clarifiers".

(2) The detention time of softening clarifiers is usually from two to four hours.

e. *Suspended solids contact softeners* are devices for the precipitation of solids from water in the presence of previously precipitated solids. These units are sometimes referred to as "sludge blanket clarifiers" or "up-flow clarifiers".



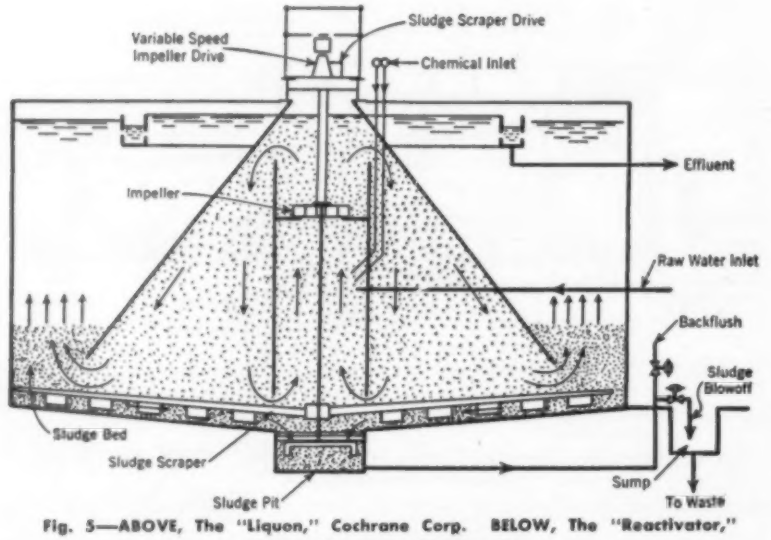


Fig. 5—ABOVE, The "Liquon," Cochrane Corp. BELOW, The "Reactivator," Graver Water Conditioning Co.

(Diagrams from "Manual of Water Quality and Treatment" by permission of AWWA.)

(1) The fundamental principle of operation is to bring incipient precipitates and colloids into contact with nuclei on which the colloids can precipitate.

. . . Return of previously formed sludge or passage of the water and chemicals through a blanket of sludge serves to provide the nuclei.

. . . Floc growth is enhanced by this mixing of previously formed sludge with newly formed and colloidal precipitates.

. . . These devices are designed to obtain the maximum benefit from this principle and the degree of chemical stability and residual hardness obtained is generally superior to that obtained in other softening process equipment.

(2) There are at least eight patented suspended solids contact clarifiers on the market. These are, alphabetically:

Accelator—Infilco, Inc.
Clariflow—Walker Process Equip., Inc.
Flocsettler—American Well Works
Hydro-Treator—Dorr-Oliver, Inc.
Liquon—Cochrane Corp.
Reactivator—Graver Water Cond. Co.
Spaulding Precipitator—Permutit Co.
Worthington—Worthington Corp.

(3) The fundamental design characteristics of all suspended solids contact softeners is based on providing these zones; (See Fig. 3, 4, 5, 6).

Water and chemical influent lines
Mixing and reaction
Flocculation
Solids-water separation
Clear water overflow
Sludge withdrawal

(4) Design of these devices is based on these factors: Overflow rate at the surface of the slurry or sludge blanket; total detention time; character of raw water; temperature; flow-through rate; and chemical dosage required.

. . . Overflow rate at the surface of the slurry is usually 1 gpm per sq ft and detention time ranges from 1 to 2 hours.

. . . The longer the detention time, the more effective the precipitation reaction, but the greater the capital investment in equipment.

(5) A basic operating principle is the development of a sludge blanket or slurry of optimum density and the withdrawal of the sludge at exactly the same rate that it is being formed, in order to maintain the sludge blanket at a constant level and quantity.

. . . Adherence to this operating principle is affected by design factors, water character, temperature, etc. and some latitude must be provided.

(6) Either manual or semi-automatic control may be provided to maintain chemical dosage, reaction time, slurry level, etc. at the desired points to obtain optimum results.

. . . Sludge concentration areas are provided to minimize the loss of water during sludge withdrawal.

(7) Coagulants may be added to aid in producing an optimum floc for the slurry or sludge blanket and in some cases activated silica as a coagulant aid has been found to improve the water-solids separation.

e. *Recarbonation* requires equipment to produce the carbon dioxide necessary for the process.

(1) Carbon dioxide may be produced by burning coke, gas, oil, or pulverized coal.

. . . The products of combustion are passed through a water scrubber and a drier and the emerging gas contains about 12 per cent CO_2.

. . . The amount of carbon dioxide produced by these fuels is:

Fuel		Pounds of CO_2
Kind	Amount	
Coke	1 lb	3.0
Mfg. Gas	1000 cu ft	82
Nat. Gas	1000 cu ft	115
Kerosene	1 gal	20

. . . Stack gases have been used in some instances but unless carefully scrubbed they may impart tastes and odors into the water.

(2) Equipment for producing carbon dioxide for recarbonation consists of several items.

Furnace in which fuel is burned.
Scrubber to remove soot and other impurities.

Compressor to force gas into water.

Flow meter and carbon dioxide meter to measure the amount of CO_2 going into the water.

. . . Compact units embodying all of these items are available on the market.

(3) The carbon dioxide is introduced into the water through some type of diffuser system in a tank for that purpose, where the detention time is a matter of minutes.

f. *Filtration* always follows the softening process and recarbonation, if employed. Filters remove the residual floc particles that have not settled out and provide a surface on which colloidal and supersaturated calcium carbonate can precipitate and be removed. If the sand grains become coated with an excess of calcium carbonate and grow too large, they must be replaced.

5 . . Operation and Control

a. Chemicals used.

(1) Quicklime — CaO — obtained by burning limestone, is commonly used. Weighing from 55 to 65 lb per cu ft, it contains from 90 to 96 per cent CaO; less than 90 per cent CaO is poor quality lime.

. . . Pebble quicklime is less dusty and easier to handle than hydrated lime and requires only 75 per cent as much by weight to be chemically equivalent to hydrated lime.

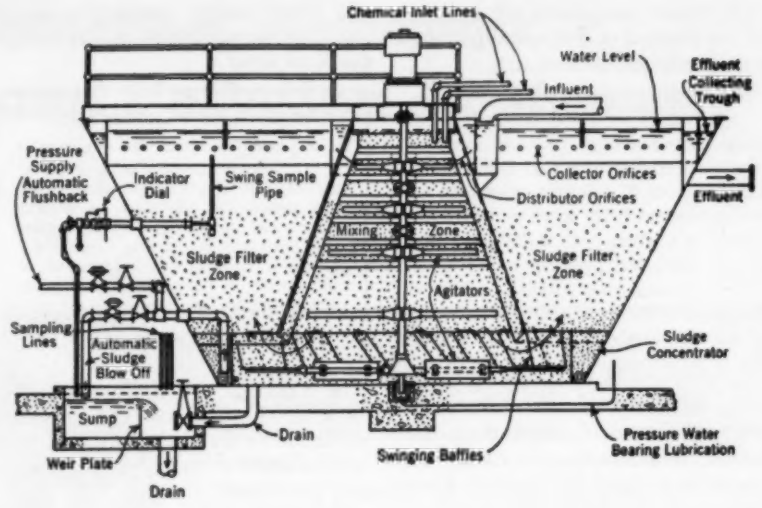
. . . Ground quicklime may be obtained in bags but it is dusty, has a tendency to arch in storage bins and feeder hoppers and it deteriorates rapidly due to air slaking.

. . . Reclaimed lime is obtained by calcining (burning) of sludge produced from the softening of water. Such reclaimed lime has been economically and effectively used in several plants, most notably at Miami, Fla. Since the softening reaction produces more calcium carbonate than needed for the reaction, Miami sells its excess to another municipal softening plant.—Water high in magnesium hardness does not produce a sludge which can be burned to produce high calcium lime; rather a dolomitic lime is produced; it is not as effective for softening.

(2) Soda-ash — Na_2CO_3 — is obtained in commercial grades about 99.5 per cent pure. It is relatively soluble in water and may be fed readily by dry feeder.

(3) Coagulants may be filter alum, sodium aluminate, liquid alum, ferrous sulfate, ferric sulfate, ferric chloride, aluminum chloride and activated silica.

(4) Carbon dioxide produced as described above.



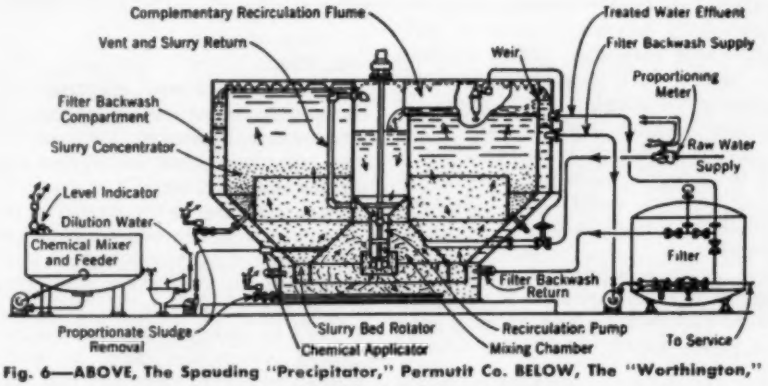


Fig. 6—ABOVE, The Spaulding "Precipitator," Permutit Co. BELOW, The "Worthington," Worthington Corp.

(Diagrams from "Manual of Water Quality and Treatment" by permission of AWWA.)

b. Chemical dosage.

(1) The analytical data, expressed in mg/L, required to calculate the dosage of chemicals required are:

. . . For lime dosage — Free CO_2, half bound CO_2 (0.44 X alkalinity), and magnesium.

. . . For soda-ash dosage — Non-carbonate hardness.

(If the complete chemical analysis of the water is known the dosage of lime and soda-ash can be calculated from the chemical constituents.)

(2) Lime required in pounds per per 1000 gallons:

[0.0106 X (Free CO_2 + half-bound CO_2) + 0.019 X Magnesium] ÷ % CaO in lime

(3) Soda-ash required in pounds per 1000 gallons:

0.009 X non-carbonate hardness

(4) Excess lime treatment requires approximately 0.03 to 0.06 lb per 1000 gal more than the theoretical dosage.

(5) If complete removal of non-carbonate hardness is not desired, then the soda-ash requirement is calculated only for the amount of non-carbonate hardness to be removed.

(6) Although each chemical is fed by a separate chemical feeder, the chemicals may be added together at the same point in the rapid mixing basin.

c. Control of softening process.

(1) Continuous flow measurement is essential in order to determine the proper feed rate for chemical feeders.

(2) Chemical feed rate must be indicated and/or recorded in order to maintain the chemical dosage at the proper level.

(3) Analytical determinations of the chemical characteristics of the raw water are necessary at intervals of time, if the character of the water is subject to variations; the length of the time interval between such analysis depends on how much and how frequent the water characteristics vary.

(4) Analysis of the process effluent for pH, alkalinity, and total hardness is necessary to the control of the process and the production of a desirable water.

(5) Where coagulants are used, the jar test method of determining dosage is an important control test.

d. Stabilization of the effluent.

(1) Water softened without recarbonation has a high pH and is supersaturated with respect to calcium carbonate; from it, calcium carbonate will precipitate on filter sand or in the distribution system and household heaters as indicated previously.

(2) Excess lime softened water recarbonated to a pH of 8.3, where all of the carbonate is converted to soluble bicarbonate will tend to become corrosive particularly in household water heaters.

(3) To avoid both of these difficulties, recarbonation is usually controlled to a pH of 9.4 at which a positive saturation index will exist.

(4) Another method, also used with pH control of recarbonation, is "threshold treatment" with a polyphosphate chemical. — Most common is the sodium hexametaphosphate; commercial brands are sold under the names "Calgon" and "Nalco."

. . . The dosage is on the order of 1 to 2 mg/L following filtration of the softened water. At Columbus, Ohio the dosage is from 0.25 to 0.5 mg/L.

. . . By a sequestering action, the excess calcium carbonate is prevented from precipitating and forming scale in pipes, meters, and water heaters.

6 . . Advantages and Disadvantages

a. According to Steel, the chief advantages of lime-soda softening are:

(1) Total mineral content and hardness of the water is reduced.

(2) The pH of the water is increased which reduces corrosiveness of the water and red water troubles.

(3) More efficient removal of turbidity of the raw water, particularly if the magnesium content of the water is relatively high.

(4) Better bacterial kill of pathogenic bacteria, particularly if the pH of the water remains in the caustic range for several hours.

(5) Iron and manganese are removed.

b. Prof. Steel also lists several disadvantages:

(1) Large amounts of sludge produced which must be disposed of.

(2) Operation requires close and skillful supervision.

(3) Unless recarbonation and stabilization are practiced, there will be incrustation of sand in filters and scaling in the distribution system and household services.

(Ed. Note: Space does not permit the inclusion in this issue of section 5e and 5f on sludge concentration and sludge disposal. They will appear in the next issue.

Important—Correction!

To pages 309-310 of the July issue

Mr. George B. McComb, a member of AWWA Committee 8310-D, has called our attention to several errors and statements subject to misinterpretation in Section G on Protective Coatings, which appeared in the article on Corrosion-11, on pages 309-10 of the July issue.

G . . . Protective Coatings

1 . . Function

a. Coatings are used to interrupt both anodic and cathodic reactions. Both the escape of cations and contact of the metal with water and oxygen are prevented.

b. Coatings are effective in corrosion control both internally and externally for pipes, tanks, etc.

2 . . Non-Metals

a. Paints.

(1) Paints are used effectively for the protection of structures against atmospheric corrosion, but are not very effective against underground or underwater corrosion.

(2) According to the Report of the "Committee on Developments in our Knowledge of Corrosion and Its Mitigation" of the NEWWA (presented at the annual meeting of NEWWA in 1949, by Moore, Sears and Rubin), "paints commonly used in water works equipment, especially that subjected to submergence or damp atmosphere, have asphaltic or bituminous bases often applied over a base coat of red lead".

. . . According to a member of AWWA Committee 8310-D, ". . . no paints, either asphalt or coal tar (bituminous) bases are applied over a coat of red lead for submerged structures, pipe or otherwise."

(3) Paints and lacquers used in connection with cathodic protection must be alkali resistant because alkali is produced at the cathode.

(4) Paints for protection of metal often employ metallic pigment, usually zinc or lead, mixed with linseed oil.

(5) Aluminum paint is popular for elevated tank storage because of its effective protection against corrosion and its pleasing appearance.

b. Bituminous Linings and Coatings.

(1) Asphaltic materials derived from natural or petroleum base are not used for coating water mains, and, according to AWWA Specifications, are not acceptable as part of the ingredients of linings or coatings.

(2) The cast iron pipe industry uses coal-tar pipe dips and steel water pipe fabricators use coal-tar enamels as provided in AWWA Standard Specifications C203-57 for "Coal-Tar Enamel Protective Coatings for Steel Water Pipe."

(3) Methods of applying these coatings include

. . . Dipping in a bath of hot tar.

. . . Applying molten coatings centrifugally on the inside; and on the outside by either manual or mechanical means.

. . . Coatings on specials or fittings may be brushed on.

(4) Steel pipe in general is given more attention with respect to coatings, especially external coatings for submerged or buried pipes.

(5) AWWA Specification C 203-57 provides for corrosion protection of steel pipe as follows:

. . . For the inside of all pipe, a coat of coal-tar primer followed by a hot coat of coal-tar enamel.

. . . For the outside of all pipe less than 30-in. in diameter, a coat of coal-tar primer followed by a hot coat of coal-tar enamel, into which is bonded a layer of asbestos felt wrap, and finished with water-resistant whitewash or kraft paper.

. . . The specifications also cover the outside of pipe larger than 30-in. in diameter, the outside of pipe to be placed above ground, and the outside of pipe to be placed below ground where corrosive conditions are greater than normal.

(6) AWWA Committee 8310-D (steel pipe) concluded some time ago, based on field studies and other tests, that asphaltic materials could not be included in AWWA Specifications.

. . . According to members of Committee 8310-D, "to date no materials of asphaltic nature have been made available through petroleum producers or the Asphalt Institute, that will compare with the performance of coal-tar enamels."

. . . Any statements in Water Supply Engineering textbooks, which indicate that asphaltic materials might be acceptable, should be considered in light of the AWWA Committee 8310-D actions and opinions.

c. Cement linings or coatings.
(no change in this section)

d. Enamels, Resins and Mastics.
(1), (2), (3), (4)—No change.

(5) Mastics are not used in water works practice.

. . . The composition of mastics, methods of applying and other information on mastics may be found in an article by Brannon, in Paper No. 2541 of ASCE Transactions (p. 165, 1952).

e. No change.

Watershed Protection, Reservoir Management and Pollution Abatement

Some factors to be considered

by WENDELL R. LaDUE

Mr. LaDue is Chief Engineer and Superintendent of the Bureau of Water Supply, Akron, Ohio. This article is adapted from a paper presented by Mr. LaDue before the Statewide Conference on Water Supply Problems, sponsored by the Water Resources Comm., Illinois State Chamber of Comm.

THE LATE PRESIDENT Theodore Roosevelt, an ardent conservationist in 1906 called a conference of the Governors of all of the States of the Union to discuss the general topic of rivers. At that conference he made the rather relevant comment to the effect that America "has managed to mismanage all of its river systems."[1] In the fifty years since that remark was made, a great deal of money, energy, time and discussion have not materially changed its import.

Today some feel that progress reports indicate real substantial improvement and hasten to recognize the vast amount of work done. Others feel that progress has been infinitesimal and the results even objectionable to the public interest. A middle of the road group, would say that much must be done that is desirable and that known processes and undertakings should be speeded up,—and now. No less an authority than "Boss" Kettering is credited with the statement that "In today's world, everybody has to work to his utmost merely to keep even with developments."

Knowledge Requirements are Multiple

Perhaps this article should be more appropriately titled "Know Your Watershed and Your River — Then Protect It." Knowing one's watershed is a substantial order, involving at least passing acquaintance with such endeavors as physical geography, meteorology, geology, silva-culture, agriculture, chemistry, sanitary engineering, and even animal husbandry. The study of a river is a fascinating thing, involving as it does, rainfall, percolation, transpiration, runoff, and evaporation; together with the many changes which are affected in the waters of the stream flow by its passage through countryside, swamp, forest farmland, treatment plants, city homes, industries, and sewage disposal systems. It makes one thoroughly appreciative of the fact that one is dealing with some of the most interesting and intriguing processes of nature; aided, disrupted and deteriorated, if you please, by the strivings and needs of mankind. Such being the case, man can look to nature for help and usually gets it, if he will but allow it.

Watershed Protection

It is well to recognize at the start that erosion is a natural process that has been going on for eons of time. The very rocks upon which many of our cities rest are generally sedimentary in character and hence the results of erosion. Flowing water causes erosion in proportion to the character of the soil over which it passes and to the extent to which that soil is protected by texture, by slope, by cover, by use. It is generally recognized that man has to use the soil to exist, but he can also use it and at the same time protect it by proper land use and by known methods of crop rotation, crop cover, contour farming, reforestation, and afforestation. In traveling over the country by plane, train, or auto, it is amazing and discomforting to observe the thousands of acres of land lying unprotected even by such a simple restorative as reforestation. However, the fairly recent upsurge of real interest in the subject of land use, and the progress made in many of the central states in the designation of existing land allotments to grazing, forestry, farming, and farm ponds, seems to indicate a more favorable trend in adequate watershed protection.

In and around Akron, Ohio, afforestation and reforestation was started in 1922, to the disgust of many, and with the support of a few. Today, a dissenter is hard to find and many have followed this example. When it is impossible to own the entire watershed, the least anyone can do is to promulgate the power of example as a very potent factor in controlling it. (Ref. LaDue—Journal, A.W.W.A., Aug. 1948). Where results are achieved others will copy; it's human nature so to do.

Allow for Siltation in New Reservoir

In Akron there are two reservoirs, one only 20-years old and the other 43-years of age. By siltation, the older reservoir, with the larger drainage area and without earlier watershed protection will be filled in about 300 years. The newer one, with smaller drainage area and with watershed protection, will be filled in about 400 years. Both of these figures are authenticated by recent siltation surveys made by independent government agencies. It is believed that modern methods of watershed protection can be made effective in extending reservoir life. As said before, erosion, and resultant siltation, are natural processes. Therefore, it logically follows that all reservoirs should be designed, wherever practicable, with a "built-in" siltation factor. For example, a new reservoir on the watershed, with a 1000-acre water surface containing 3.26 billion gallons or 10,000 Ac. Ft., with a 400-year siltation life expectancy, could have that expectancy increased 25%, or 100 years by raising its designed level less than 2.5 ft. A study of the topog-

raphy and of the economics of the design would undoubtedly indicate the practicability of such procedure when compared with the earlier loss of a reservoir. Reservoirs on watersheds indicating greater siltation problems could be relatively considered. Why not, therefore, more than ever, recognize siltation as a factor in multiple-purpose reservoir planning?

Reservoir Management

This term involves the many factors of contingent area use, sanitation, siltation, pollution, recreation, and the general factor of public relations. In many areas this may become purely a matter of aesthetics, in others, costs, and in still others, the real, dire need for recreational facilities. No general rule can apply to all cases, but it appears that some areas are fast approaching acceptance of the premise that any decision on recreation or other secondary uses of water impounding reservoirs be left entirely to local discretion. The problem is of such present moment, and so diversely considered, that the Board of the American Water Works Association, at its recent meeting at Atlantic City, authorized the creation of a Task Group to consider and report upon the background of this statement: "As a matter of national policy that recreational uses of domestic water supply reservoirs should be permitted only under conditions that assure full and positive protection to safeguard the purity of water used by people for drinking and other domestic uses." The problem is further complicated by findings, in connection with the use of Ohio River waters for domestic use, that raw waters, which contain a very substantial amount of industrial and sewage pollution, can, and are being purified by known modern treatment so as to be safe and satisfactory for use by the consumers. Herein must be a realization and admittance of the cost factor and the acceptance by the public of the added cost for service.

Government Recognition

President Eisenhower said in a recent letter to the Water Resources Council, Inc.: "The development of a national clean stream program is a step in the right direction. Water is one of our most critical resources and the pollution of our waterways is an extravagant waste. As our people are alerted to their responsibility in this vital area and encouraged to accept strong voluntary controls originating in their local communities and states, I am sure the national health and economy can be strengthened."[2]

The Water Resources Council believes that pollution, besides being destructive of life and property is "the nation's most extravagant waste of water. Pollution abatement is not so much a matter of needing strong anti-pollution laws as it is one of winning and keeping the public's support for the laws we now have."

Pollution Abatement

This is a problem wherein big dividends and big stakes are involved, one way or another. It is a manyfold one, but principally three factors are involved: (1) To locate, ameliorate, or eliminate known and very significant sources of both domestic and industrial pollution, (2) To prohibit, prevent or reduce by all known means any new sources of pollution, and (3) To utilize fully any natural self-cleansing or self-purifying capabilities of the receiving streams (analyzing each area separately) considering present uses and future possibilities.[3]

Protection of surface supplies will become more and more necessary as potential capacities are developed in critical population concentrations of our country. The general public is awakening rapidly to the critical relationship between clean waters, on the one hand, and the public health and welfare on the other. One is forced to recognize the build-up of concentration and the possible development of new compounds which may result as waters progress downstream with successive use, re-use, and passage through multiple water plants, distribution systems, and sewage disposal plants. Indicative of this are the recent experiences of many cities located along the Ohio River, with the effects of sewage-borne synthetic detergents. Manufacturing processes are continually producing new, strange, and puzzling compounds with unknown capabilities. This poses the question: Should the pollutant be segregated and treated at the source or is treatment more cheaply and more efficiently accomplished at the water plant? Much has been said on both phases.

Over the years, the policies of pollution abatement exercised by both cities and industries have been, at best, devoid of most principles of good or decent housekeeping.[4] Sewage goes downstream so that the offender's neighbor, not the offender, suffers. How long will it be until responsibility is fully recognized by the general public? Fortunately there are concrete evidences everywhere that such recognition is gaining strength; again for example, the Ohio River Compact.

Adequacy of Water Resources Questioned

The increase in per capita use of water in the U.S. raises the question as to the adequacy of our existing water resources to meet foreseeable future demand. The re-use of water has not as yet been explored to its full capabilities, not even in areas of present scarity.[5] This foretells the immediate necessity of source inventories and of no little self-searching into our ingenuity in the use and re-use of water and the abatement and control of obnoxious and harmful wastes. It must be realized that even though pollution abatement be attainable, the problems of proper use and better conservation will still remain factors of great importance in the proper solution.

New Demands on Water Treatment Facilities

The problem of water quality has been well labeled as a "rat-race" between pollution on the one hand and purification and treatment on the other, with the margin of safety, in general, narrow and oftimes precarious. Up to now, conventional water treatment plants have handled the situation with marked success.[6] There is evidence, however, that future demands may be imposed beyond the capabilities of plants and facilities now provided and not readily subject to radical improvement. In theory, the adjustment of water treatment for pollution control can be amenable to successful simple procedures. "It would involve the proper design, construction, and operation of a highly flexible water treatment plant, including every physical, chemical, and biological facility known to science." To date, it is not believed that such a plant has ever been built by any city or industry. In the simplest ultimate terms, "pollution is the fouling of natural water by wastes to such an extent that the water is rendered in varying degrees unsuitable for human consumption or for industrial purposes." As shown by the Ohio River experiments, heavily polluted waters may be successfully treated by varied combinations of known conventional processes for various uses. The treatment becomes a matter of degree rather than type in most instances; biological processes are indicated, and of course, there emerges the item of additional costs.

Technical Advances or Legal Restrictions

In our industrial world it is becoming apparent that stream pollution is a natural result of modern living. Is it wishful thinking to assume that the arts and sciences of this same industrial world will prove adequate compensation? Is this "nip and tuck" race to be considered a minor gamble when such large stakes are in evidence? Today's gamble may well prove to be tomorrow's near disaster. The problem is constantly changing, —older problems fade away to be replaced by new, more fascinating ones, without the adjunct of comparable previous experience so important to successful solution. Waterworks men are in the middle and would like to pose this question to their civic leaders: "Are you willing to have this river become an offensive water course as a part of the price of industrial development of the river basin?"[7]

The waterworks man and the industrial engineer prefer a frank approach to the question. They are realists, they like to arrange their problems in an orderly manner so that they may have reasonable assurance that a logical solution will result. Industry is doing much, both actively and by research, to reduce stream pollution. If there be any criticism it can be found in the realization that many heavily attended conferences of industry are not publicized, hence there persists the public misunderstanding that little or nothing is being done. As a matter of plain fact, leaders of major industries have long since determined upon the fundamental policy that the production, processing, and disposal of wastes shall be an integral part of the design of all new and expanded plants and processes. This is a very foreward looking step, tailored to meet new problems with new solutions.[8]

Past events have proven that laws of prohibition do not always correct or abate pollution of our water courses. B.O.D. is not satisfied by, or acidity neutralized by fines assessed and paid as a result of court action. Corrective measures must always be technical, not legal. On the other hand, it cannot be said that legislation is not necessary—it must always be on guard and provide a measure of protection. It is pertinent, however, that such legislation and regulations not exceed the proven arts and sciences of waste disposal and water treatment. When the public requires that our industries operate, and decree at the same time that stream degradation cease, we know that cooperative efforts must produce a workable answer.

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2. A.P.W.A. Newsletter, June, 1957
4. Wolman—Jour. AWWA, July, 1946
3. Poole—Jour. AWWA, July, 1954
5. Wolman—Jour. AWWA, April, 1952
6. Faber—Jour. AWWA, January, 1951
7. Hedgepeth—Jour. AWWA, June, 1947
8. Hedgepeth—Jour. AWWA, January, 1951

Industry and Municipalities Cooperate to Solve Stream Pollution Problem

The Somerset-Raritan Valley Sewerage Authority and the American Cyanamid Co. have entered into a formal agreement with the official signing of a 20 year contract covering the secondary treatment of municipal effluent from Somerville, Raritan and Bridgewater Township.

The signing of the agreement culminated many years of painstaking work by the management of Cyanamid and the Boroughs of Somerville, Raritan and Bridgewater Township to develop a workable industry—community solution to pollution problems in the upper Raritan River.

Under terms of the contract, Cyanamid has agreed to treat the wastes of the three Boroughs at a reasonable cost in its new $4,500,000 secondary sewage treatment plant, now under construction. These wastes will, however, first be given primary treatment by the Authority in a new primary treatment plant to be built by the Authority, itself, adjacent to the Cyanamid plant.

It is estimated by the Authority's engineers that annual savings to the municipalities participating in the joint endeavor will be approximately $38,000 a year. The communities will save capital costs and amortization charges since, under the agreement, they will not be required to incur the expense of building secondary treatment facilities and assuming these additional operational costs. At the same time, the contract provides the three municipalities with adequate safeguards should their effluent problem increase during the next 20 years because of anticipated growth in their populations.

Total project costs for the Somerset Authority covering the erection of the primary treatment plant and the interceptor sewer from Bradley Gardens to the plant site, are now estimated at about $2,850,000. This is substantially less, of course, than would have been the case had the Authority decided to build its own secondary facilities.

The agreement provides that should Cyanamid go out of business at Bound Brook during the 20 year period, it will still make available to the Authority, at no cost, a part of its facilities with which the Authority can give its effluent secondary treatment. The three member municipalities are guaranteed facilities for secondary treatment for their effluent for the life and any extended period of the contract. This defers for them the time when they might have to build their own secondary treatment units.

The contract further provides that when the 20 year period or an extended period is concluded, Cyanamid will give the Authority permission to build a pipeline through Cyanamid property so it will still be able to discharge its effluent to the Raritan River.

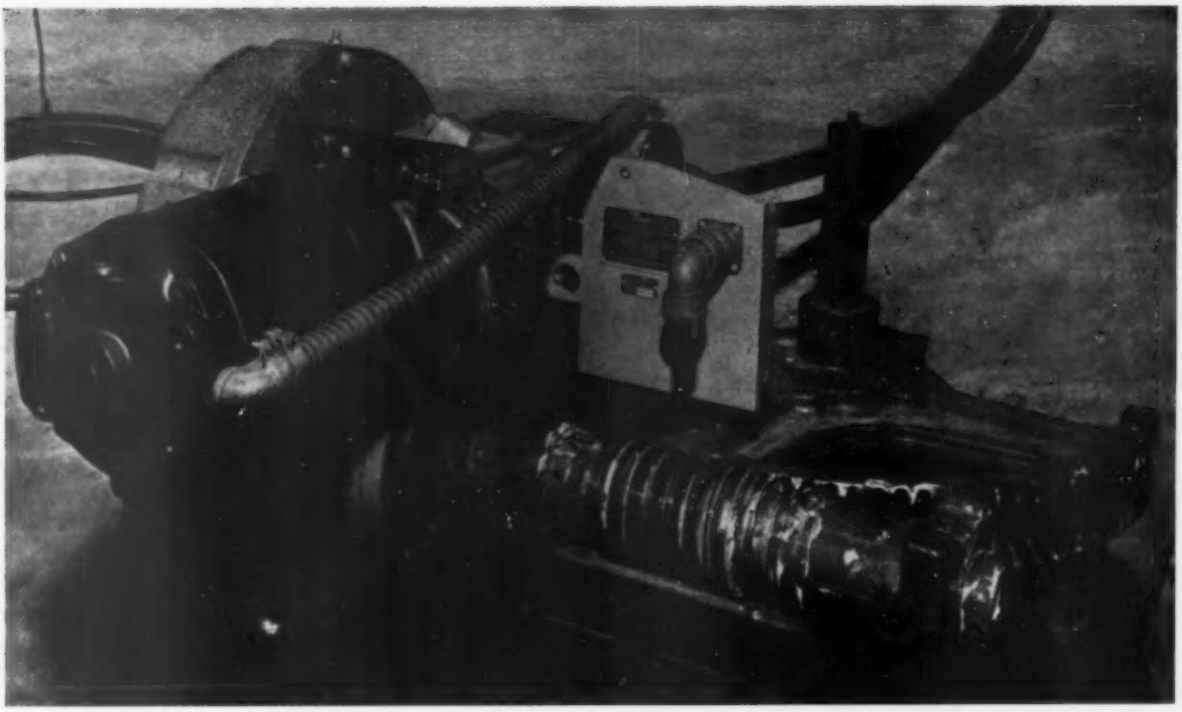
In the words of F. L. Hess, Chairman of the Authority: "This contract represents a real step forward in solving the problems of stream pollution and shows what can be done when industry and local government work together in good faith."

A Seminar on Oxygen Relationships in Streams

A three-day seminar on oxygen relationships in streams will be held by the U. S. Public Health Service at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, October 30 to November 1, 1957.

Purpose of the meeting is to stimulate research through interchange of most recent available information about problems related to the dissolved oxygen resources of streams. With the growth in sewage and industrial waste treatment, the subject of dissolved oxygen resources of streams has taken on major economic significance. Names of those on the list of lecturers reads like a roster of "Who's Who in Sanitary Engineering."

Advance copies of the program and information about attendance may be obtained by addressing the Director, Robert A. Taft Sanitary Engineering Center, Cincinnati 26, Ohio, attention W. W. Towne.



POSITIONING DEVICE mounted on valve 10 miles from control unit translates wired impulses into action

Digital Remote Control and Telemetering System

Unique valve control by dial system used by Metropolitan Water District of Southern Calif.

by J. R. BURGARD and D. E. WASSALL
Respectively, Applications Engineer and Head of Application Engineering, Data Transmission Division, Bendix Aviation Corp., North Hollywood, Calif.

THE METROPOLITAN Water district of Southern California, whose aqueduct from the Colorado River is the longest and largest domestic water supply line in the world, is now operating a novel remote control and telemetering system used in conjunction with the positioning of a valve on one of their distribution lines.

Although valve control and position telemetering is not necessarily new in the water industry, a system operating between Corona Del Mar reservoir and a valve location in Santa Ana, Calif., is unique in the industry. This system is unique in that it is of a *digital* character, employing the very latest analog-to-digital converter and digital transmission techniques. Advantages of the system lie in the extreme accuracy with which data are transmitted regardless of the changes of characteristics of the transmission link.

Functionally, personnel living adjacent to the reservoir are able to observe the level of water in the reservoir. At various intervals, dependent upon demand, the position of a valve in a 36-inch main feeding the reservoir must be altered to maintain the reservoir level reasonably constant. In former years any change in the position of the valve required that an operator drive 10 miles in each direction in a pick-up truck to the valve location and making an educated guess as to how much further to open or close the valve to compensate for the changed demand rate.

The new system, which is one of the first of the Bendix "Electro-Span" Digital Telemetering Systems commercially installed, permits operation of the valve, as well as telemetering of the position of the valve, over a leased simplex telegraph circuit, which is the lowest cost leased circuit available.

The operator at the reservoir, upon observing the need for change of position of the valve, merely steps to a telephone dial mounted on a panel, and dials according to the following code. Dialing numeral 2 causes the electric valve operator to be energized in such a manner as to cause the valve to open wider. Dialing number 3 energizes the valve positioning device in such a manner as to cause the valve to close. Dialing numeral 1 stops the change of position of the valve.

The full-scale travel from full open to full close of the valve takes approximately 19 minutes, and the operator is able to observe, automatically tele-

metered at 1-minute intervals, the position of the valve to ½ percent increments. The valve position as telemetered is recorded on a continuous strip chart on a 1-month roll.

Electrically, the system operates without the use of vacuum tubes, employing time-proven telephone-type relays and stepping switches. An electro-mechanical analog-to-digital shaft position converter (code disc) is geared to the valve shaft. As the shaft rotates through its full change of position 200 different codes are experienced on the coder. A rotating assembly, triggered every minute, cyclically scans the code disc and transmits a series of d-c pulses in an 8-digit code identifying the position of the valve.

Command orders, which are transmitted in the opposite direction by dialing the operator's telephone dial, position a minor switch to the selected position in order to effect the energization of the proper coil in the reversing motor starter for a valve operator.

In approximately one year of operation, following the original installation and de-bugging (including a shorted telephone circuit), the only failures which have been experienced were those in connection with the cycling timing motor and are mechanical in nature. Steps have been taken recently to reduce the duty cycle by a factor of six on this motor, as well as to re-orient the motor to experience longer motor bearing life.

Use of the strip chart record output permits direct compilation of total flow quantity information, inasmuch as a continuous plot is shown of valve position *vs* time. Because the District operates with an essentially constant head, it is a simple matter to extrapolate total flow quantity from this strip chart.

The manufacturer of the telemetering equipment has advised the user of the availability of equipment for automatically maintaining constant reservoir level through the means of a float gauge in a stilling well in the reservoir itself.

A long-range view of the use of euqipment of this type shows many interesting possibilities. Because the information concerning the valve position is received in digital form, it can be readily seen that ultimate operation of a pipeline network can be materially aided by use of a computer working on the incoming digital information, representing valve position, flow, temperature, and other measurements.

A system of this general type already exists (also designed and supplied by Bendix) in which weather information is collected from a number of remote points in much the same manner as the information concerning the water valve position. These data are automatically placed on punched cards and then fed to a computer for use in short-term weather predictions.

CONTROL UNIT consists of dialing device (lower right), telemetering valve position indicator is mounted on wall panel.

BALANCING RESERVOIR whose level is maintained through remote positioning of valve by dialed impulses.

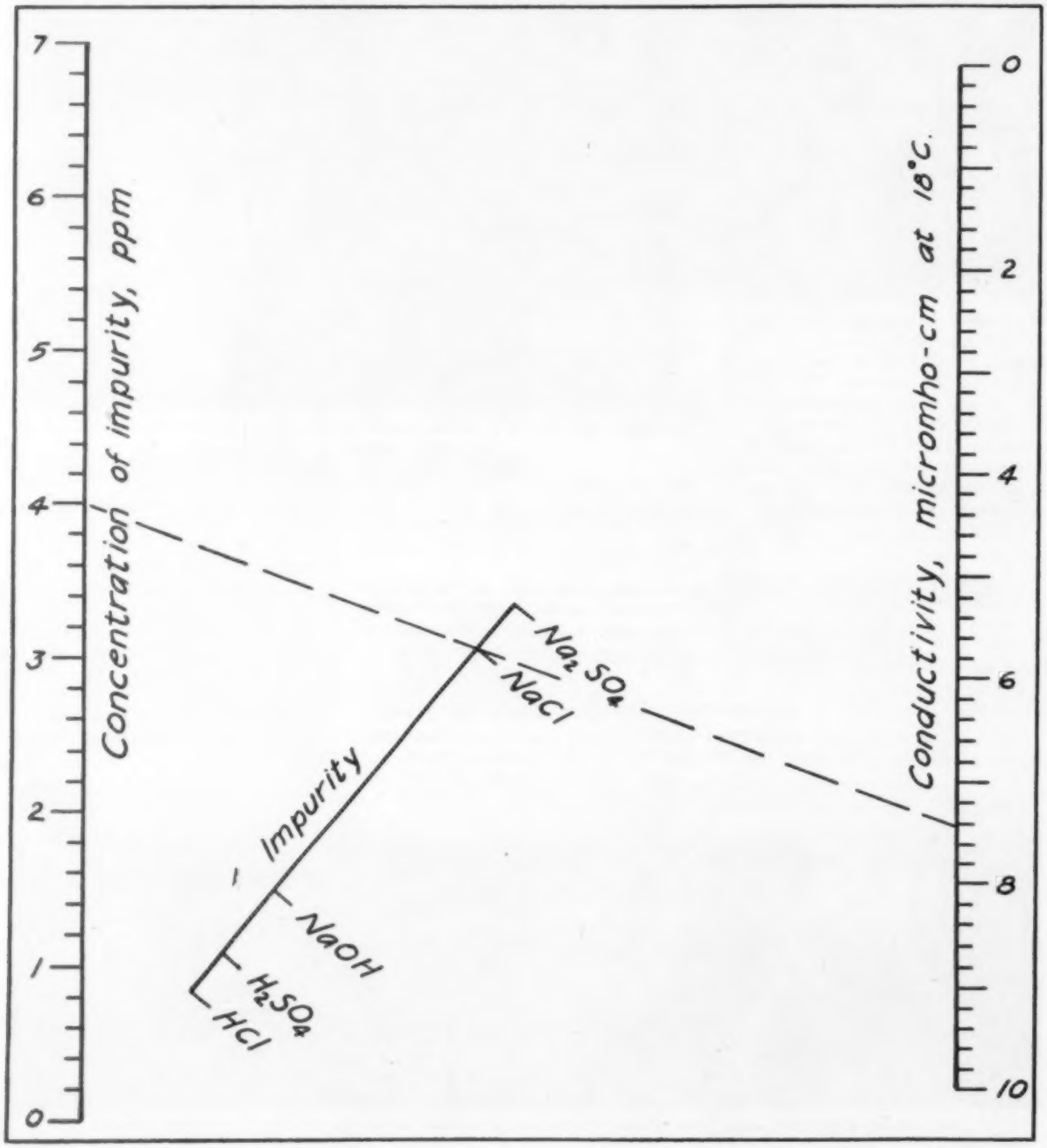
Concentration of Impurities in Water

A nomograph

by D. S. DAVIS
Professor of Engineering
University of Alabama
Tuscaloosa, Ala.

MANY PROCESSES require deionized or distilled water that contains a maximum of 5 ppm of dissolved electrolyte. However, such high purity water is more corrosive toward iron and steel than is less pure water, especially in the presence of dissolved oxygen. Concentrations of electrolytic impurities in water can be estimated through use of the nomograph, which is based on a chart given by Friend[2] that was calculated from ion conductance data presented by Glasstone[3].

The index line on the chart, which was constructed by well-known methods[1], shows that if the conductivity of water known to contain only sodium chloride is 7.4 micromho-cm at 18° C., the concentration of that impurity is 4 ppm.



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(3) Glasstone, Samuel, 'Textbook of Physical Chemistry,' page 880, New York, D. Van Nostrand Company, Inc.

How to Make

Alkalinity Measurements in Water

by G. DONG, R. L. GIUSTI, and A. E. GREENBERG

Messrs. Dong, Giusti, and Greenberg of the Division of Laboratories of the California State Department of Public Health, are respectively Assistant Public Health Chemist, Associate Public Health Chemist, and Chief of the Sanitation Laboratory in Berkeley, Calif. In this article the authors present a readily usable modification of the standard test.

THE 10TH EDITION of *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes*[1] introduced a new concept into the procedure for the determination of alkalinity in water. This concept is that the equivalence point in the titration varies with the total alkalinity and that, therefore, different equivalence points must be selected for the titration of waters of different alkalinities. According to *Standard Methods* the following pH values should be used as the equivalence points for the corresponding total alkalinities as calcium carbonate: pH 5.1 for total alkalinities of about 30 mg/l, pH 4.8 for 150 mg/l, and pH 4.5 for 500 mg/l.

Although the term equivalence point and its method of calculation are well known to chemists, the plant operator who makes alkalinity titrations may be confused by this new complication in *Standard Methods*. It is the purpose of this paper to present, in as simple a form as possible, a discussion of alkalinity and its measurement.

Definitions

Alkalinity is a measure of the quantity of basic compounds present. It is measured by titration with an acid of known strength. Alkalinity in water is due principally to carbonates, bicarbonates, and hydroxides. Borates, phosphates, and silicates also contribute to the total alkalinity; since their concentration is usually small, especially by comparison with the carbonates and bicarbonates, they are customarily neglected in calculations.

The pH of a solution is a measure of the intensity of acidity or akalinity. pH is measured on an arbitrary scale from 0 to 14. It should not be confused with alkalinity which is a measure of quantity.

The equivalence point is that point in a titration at which an amount of a standard solution exactly equivalent to the substance sought has been added. This is also known as the theoretical end point. In an alkalinity determination the equivalence point corresponds to that pH at which the quantity of added acid is exactly equal to the quantity of alkalinity present in the sample.

The end point of a titration is that point at which an abrupt observable change occurs. Ideally this is at the equivalence point. In an alkalinity titration using indicators, the color change does not necessarily occur at the theoretical end point. This may lead to an appreciable error in the titration. When using a pH meter, however, an abrupt change in pH is observed at the theoretical end point.

Theoretical Discussion

When sulfuric acid is gradually added to a solution of sodium carbonate, two reactions take place: First, all of the carbonate is converted to bicarbonate:

$$2Na^+ + 2CO_3^= + 2H^+ + SO_4^= \rightleftarrows 2Na^+ + 2HCO_3^- + SO_4^= \quad (1)$$

Second, after all of the carbonate has been converted, the resulting bicarbonate is converted in turn to carbonic acid:

$$2Na^+ + 2HCO_3^- + 2H^+ + SO_4^= \rightleftarrows 2Na^+ + 2H_2CO_3 + SO_4^= \quad (2)$$

Plotting the results of such a titration of sodium carbonate, using milliliters of standard acid as the abscissa and pH as the ordinate, the curve shown in Fig. 1 is obtained. This curve is typical of a carbonate system in that it shows two equivalence points. Point B is the bicarbonate equivalence point; that is, the pH at which all of the carbonate has been converted to bicarbonate (Equation (1) above). This occurs at pH 8.3. Point C is the equivalence point for carbonic acid; that is, the pH at which all of the bicarbonate has been converted to carbonic acid (Equation (2) above). In the determination of alkalinity in water, Point C is of prime importance because it indicates complete neutralization of the bases present.

The pH at these end points can be calculated for any given set of conditions. Since the titration involves two equivalence points, there are two ionization equilibria to be considered:

$$CO_3^= + H^+ \rightleftarrows HCO_3^- \quad (3)$$

and

$$HCO_3^- + H^+ \rightleftarrows H_2CO_3 \quad (4)$$

The ionization constant for reactions[3], K_2, is expressed as

$$K_2 = \frac{[H^+]\ [CO_3^=]}{[HCO_3^-]} . \quad (5)$$

Solving for $[H^+]$ yields

$$[H^+] = K_2 \frac{[HCO_3^-]}{[CO_3^=]} . \quad (6)$$

Converting to logs of the reciprocals we have

$$\log \frac{1}{[H^+]} = \log \frac{1}{K_2} - \log \frac{[HCO_3^-]}{[CO_3^=]} . \quad (7)$$

Since $\log \frac{1}{[H^+]}$ equals, by definition, pH, equation (7) may be rewritten

$$pH = \log \frac{1}{K_2} - \log \frac{[HCO_3^-]}{[CO_3^=]} . \quad (8)$$

K_2, the ionization constant is known. It equals 4.7×10^{-11}. Substituting, we find

$$pH = \log \frac{1}{[4.7 \times 10^{-11}]} - \log \frac{[HCO_3^-]}{[CO_3^=]}, \quad (9)$$

or

$$pH = 10.2 - \log \frac{[HCO_3^-]}{[CO_3^=]}. \quad (10)$$

In the same way, equation (4) is solved. K_1, the ionization constant, is

$$K_1 = \frac{[H^+]\ [HCO_3^-]}{[H_2CO_3]}, \quad (11)$$

and

$$pH = \log \frac{1}{K_1} - \log \frac{[H_2CO_3]}{[HCO_3^-]}. \quad (12)$$

Since $K_1 = 4.3 \times 10^{-7}$, then

$$pH = 6.4 - \log \frac{[H_2CO_3]}{[HCO_3^-]}. \quad (13)$$

Using equations (10) and (13), the equivalence points for a series of titrations of solutions of different alkalinities were calculated. These are shown in Table 1. It is clear from this table that the bicarbonate equivalence point occurs consistently at a pH of 8.3 ± 0.1. However, it can also be seen that the carbonic acid equivalence point varies rather widely and decreases with increasing alkalinity. Thus, the recommendations of *Standard Methods* are entirely consistent with theory.

Practical Considerations

In the analysis of unknown samples it is obviously impossible to know the total alkalinity or the correct equivalence point to use in measuring the total alkalinity. This difficulty may be eliminated in several ways: (1) Titrate the sample to any arbitrary pH end point around 5 to establish the order of magnitude of total alkalinity. Use this approximation to select the correct equivalence point and complete the titration, or (2) select a pH for routine use on all samples which will provide a minimum error in the total alkalinity.

TABLE 1

Equivalence Points Calculated for Different Alkalinities*

Alkalinity mg/l as $CaCO_3$	Equivalence Point Carbonate-Bicarbonate	Carbonate-Carbonic Acid
30	8.2	5.1
60	8.2	5.0
150	8.3	4.8
200	8.3	4.7
500	8.3	4.6
1,000	8.3	4.5

*Na_2CO_3 solutions titrated with 0.02N H_2SO_4

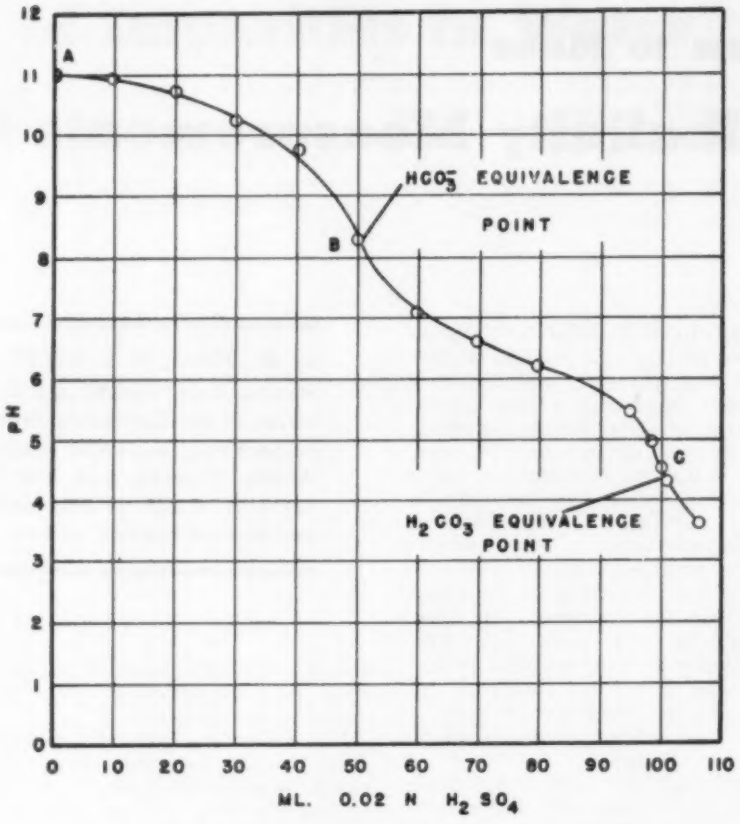

Fig. 7. Titration curve of 1,000 mg/l NA_2O_3 with H_2SO_4

The 9th and earlier editions of *Standard Methods* used the second alternative. By specifying methyl orange as the indicator the end point was taken at about pH 4.3. The errors resulting from the use of pH 4.3 as the end point in the determination of total alkalinity may be considerable. They are shown in Table 2. Note that at low alkalinities the error is large, but that it decreases as the alkalinity increases. For good reason, then, the 10th edition of *Standard Methods* has changed the recommended procedure.

The first alternative given above is, however, not a universally acceptable one since it involves additional complications which may thoroughly discourage the plant operator. Our laboratory has simplified this by using a single pH value as the end point for all alkalinity titrations; by carefully selecting this value, we have minimized the errors. The pH of choice is 4.8. In Table 3 are shown the errors which are much smaller than those obtained with a pH of 4.3.

It is true that the selection of pH 4.8 as suggested here, or the sliding pH values given by Standard Methods, means that methyl orange can not be used as the indicator. However, inspection of Table 2 shows that the error in total alkalinity, when using methyl orange as indicator, is 5 mg/1, or very close to it. Therefore, those who are familiar with methyl orange and wish to continue its use may simply subtract 5 mg/1 from the methyl orange alkalinity and be within one percent of the actual value. Methyl orange is, unfortunately, a notoriously difficult indicator to use. The mixed brom cresol green-methyl red indicator given in *Standard Methods*, or, better yet, the methyl purple indicator suggested by Fleisher[2] and Frey[3] would be preferable. This indicator has a very sharp color transition from green to purple at

TABLE 2

Deviations in Total Alkalinity Using pH 4.3 as End Point

Total alkalinity at theoretical equivalence point mg/l	Total observed alkalinity using pH 4.3 as end point mg/l	Deviation %
30	35	+16.7
60	65	+ 8.3
150	156	+ 4.0
200	206	+ 3.5
500	505	+ 1.0
1,000	1,005	+ 0.5

pH 4.8. Ideally, a pH meter can be used.

Summary and Conclusions

The relationship between the total alkalinity and the equivalence point in the titration of total alkalinity has been verified.

To eliminate the sliding scale of pH end points for samples of different alkalinities, it is suggested that pH 4.8 be taken as the end point in all titrations. This pH can be accurately measured by means of methyl purple indicator or a pH meter.

TABLE 3

Deviations in Total Alkalinity Using pH 4.8 as End Point

Total alkalinity at theoretical equivalence point mg/l	Total observed alkalinity using pH 4.8 as end point mg/l	Deviation %
30	31.5	+5.0
60	62	+3.3
150	150	0.0
200	197	−1.5
500	495	−1.0
1,000	990	−1.0

References

(1) Standard Methods for the Examination of Water, Sewage, and Industrial Wastes, 10th ed. A.P.H.A., New York (1955).

(2) Fleisher, H., "Sensitive Indicator for Volumetric Determination of Boiler Feedwater Alkalinity." Ind. Eng. Chem., Anal. Ed., Vol. 15, 12, 742-743 (1943).

(3) Frey, R. W. "Methyl Purple vs. Methyl Orange in Alkalinity Titrations." Water and Sewage Works, Vol. 100, 6228 (1953).

Intelligence Needed to Prepare for Future Water Demands So Says AWWA Secretary Jordan at APWA Meeting

Speaking before the General Conference of the Amer. Public Works Assn. in Philadelphia on Sept. 24, Harry E. Jordan, Secretary of AWWA said, "Provisions for the future water demands of the growing American population and expanding industries can be made from the country only if intelligent land use becomes the fashion and water storage developments are made to meet the period when day-by-day normal stream flow will be inadequate."

Quoting the phrase "the American oasis," the title of a recent book by Edward Higbee, to describe America's physical advantages, Jordan stated that, in agricultural and industrial potential, based upon climatic and rainfall conditions, no other part of the globe is as favored as the temperate zone of the U. S. Having been blessed with such abundance, he continued, we, as a nation, do not recognize the immense value of those conditions. For the future, however, if we are to meet the greatly increased demands of growing populations, industrial development, and the more lavish water-usage habits of the American public, it is urgent that we begin now to work toward permanent nation-wide water conservation programs.

"The primary responsibility for water conservation measures," Jordan continued, "rests with the farmers. Many of the present difficulties, as well as the difficulties which are clearly envisaged for the future, lie at the doorstep of the agricultural population of the United States." He went on to describe how improper land use is not only destructive of our best farm areas, but results in an eventual chaos of uncontrolled water waste and further erosion and depletion. Not only is useful top soil carried away by winter rains coursing across bare unterraced fields, he said, but the streams and the reservoirs fed by the streams are gradually filled up with the washed-away soil. Under those circumstances, valuable water neither benefits the soil nor is stored for future periods of drought; it merely washes its way back to the sea. "In the eastern part of the United States, Jordan stated, "from the Missouri and the Mississippi to the Atlantic coast, existing reservoirs cannot long serve as reservoirs unless the habits of the agricultural population on the watersheds of these streams are changed. Once a reservoir site is silted up and lost, it can never be replaced."

Using the Missouri River watershed areas as an example, Mr. Jordan said that unless soil conservation measures are enforced on the Missouri River watershed, "the entire construction program will be lost for any useful purpose at the end of two or three centuries." He went on to discuss the need for an inter-departmental agency at Cabinet level to develop and promote integrated thinking and planning of land and water use and conservation.

In relation to water for municipal and industrial uses, Jordan pointed out that the rapid increase of concentrated populations makes it "impossible for any city of importance not located on the Great Lakes or the main stems of the Missouri, Mississippi, or Ohio Rivers to omit from its development plans the construction of water storage reservoirs." Here, again, he stressed the importance of intelligent land use and water conservation.

In relation to industry he showed how it has been proved that successful production can be carried on under strict water conservation practices which bring water requirements down to as little as one-fiftieth the amount used when water conservation is not practiced.

In closing, Jordan stated that "ample supplies of food and water for all people who wish to live in this country can be forseen. Intelligence, however, must be the watchword in achieving those objectives."

Iraq-Saudi Arabia Seeking Consulting Engineering Services

For Projected 465-Mile, $28 Million Water Pipeline

An agreement has been reached between Iraq and Saudi Arabia calling for the construction of a 465-mile water pipeline from a point on the Euphrates River near Suq al-Shuyukh in Iraq to Riyadh, Saudi Arabia. Overall cost of the project is estimated at $28 million.

The Saudi Arabian Government, which will be largely responsible for constructing the project, is seeking the services of an international consulting engineering firm to make a thorough study of the practical aspects of the projects. United States firms interested in participating in any phase of the engineering or construction of the proposed pipeline can obtain additional information from the U.S. Embassy in Jidda, Saudi Arabia.

Preliminary plans indicate the work will include two 32-inch pipelines, a purifying and pumping station near the starting point, several booster pumping stations along the way and outlets for irrigation in cultivable areas. The project, it is estimated, will supply Riyadh with 30 million to 40 million gallons of drinking water daily.

Ain't Nature Wonderful

The only thing that can cheat some people out of the last word is an echo.

Electrical Supervisory Controls

by MARVIN H. SCHROEDER

Mr. Schroeder is Director of Utilities for the City of Vancouver, Washington. Since his appointment as Director in 1952, he has been a moving force in the adoption of supervisory controls for Vancouver's water and sewage facilities.

Main Control Panel and the Author

THE CITY of Vancouver, Washington, celebrated its one-hundredth birthday on January 23, 1957 and has grown to the fifth largest city in the State, with a population of 42,000.

The City did not own its water supply until June 1, 1937 when it was purchased from "Peoples Water and Gas Company", which at the time of purchase had some 4,500 accounts.

The Water Department today serves an area of approximately twenty square miles and has some 15,000 accounts, serving a population both inside and outside the City of some 52,000 people. The supply of water for Vancouver is obtained from two sources, springs and wells. From Ellsworth springs, located five miles East of Vancouver, 2.0 to 2.7 M.G.D. is received, the rest is pumped from fourteen deep wells located throughout the City. These wells deliver 25.9 M.G.D., they vary in depth from 186 to 287 ft and deliver from 1,000 to 2,000 gpm.

The deep turbine pumps are driven by 100 and 150 hp electric motors. There are also six auxiliary gas powered motors for four of the deep wells and two for the booster pumps in case of electric power failure.

The water from Ellsworth springs and that pumped from the deep wells is delivered to four ground level storage reservoirs of 14.8 M.G. capacity and four elevated tanks of 1.3 M.G. storage capacity. Due to the terrain, it is necessary that approximately one-third of the water used is repumped from ground level storage reservoirs to elevated storage tanks.

In September 1952, a complete study was conducted of all water and sewer facilities. After several months the report showed the most trouble and expense was in pump controls and various water level operations.

It is upon this investigation and the distance between the various pumps and reservoirs, that a complete new system of controls was installed to automatically control these operations at one central station.

During the study, contacts were made with other City Water Departments and inspection trips were made to determine the type used with the most success, and also one that would be best suited for the Vancouver system.

The system adopted requires no radio tubes, or radio frequencies; positive application is used to each of the pumps. Each unit, consisting of a transmitter, receiver and recorder are on one separate circuit. This is a decided advantage because, in the event of a line power failure, it does not in any way affect the rest of the water system as to control and recordings.

System Automatically Performs Control and Alarm Functions

Each system has its own alarm and also a red light under each recorder for the quick location of trouble. A test button on each system is also available at the main station to check all equipment at the other stations. Each deep turbine well has a metered timer showing running time and gallons of water pumped.

These controls will automatically permit the use of all gravity spring water to be used before the deep well turbines are started. In case of complete power failure, protection is provided by means of a battery hookup for alarms. There is also available a secondary source of electric power.

Hand-off automatic switches are used by servicemen to check all equipment in a pump house without interference with the automatic control system. Before the installation of this automatic equipment five men were required for checking reservoirs and pumping stations; today one man performs these duties, as well as repairing meters and checking the control panel. He can tell at a glance the water levels in all reservoirs and tower tanks, how many pumps are in operation and which one is on the line.

System Also Controls Sewage Plant

Night watchmen are no longer used at either the water station or the sewage treatment plant, as the same type of controls are also installed in six sewage pumping stations, and at the treatment plant. At the close of the second shift change at 11:00 p.m. each operator turns on a switch which places the main control panel in complete charge of all operations and then goes home.

At the main control center, a house is occupied by one of our servicemen. An alarm has been installed near his bed, so that in case of any failure in the system it would be transmitted to his alarm from the main control panel by two short rings for sewage and one continuous ring for water. If there is any trouble at night he looks at the main control board, determines the trouble and its location and then calls the serviceman and instructs him as to the trouble and its location. Before returning to bed, he has a reminder that he sets for thirty or more minutes, that if repairs are not made by that time, the alarm will sound again.

From our experience a full reservoir is getting all the return for your capital investment. Also, more personnel working on other improvements is making progress, rather than just making calls to see if reservoirs are full and pumps are operating.

These controls have been in operation successfully for the past four years and have more than paid for themselves.

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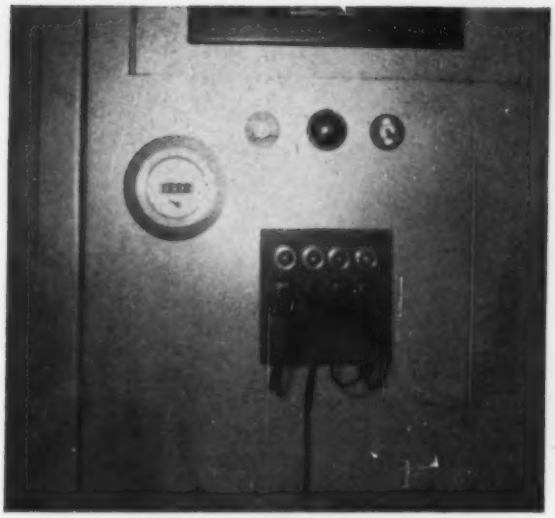
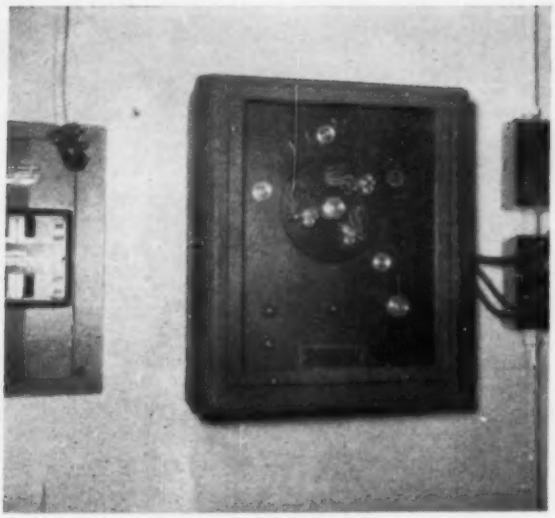


Jack Plugs for Pump Alternation

The plug-in arrangement above was included so that pumps could be alternated as to the sequence of operation. Such as, number four pump can be in position one and two in position three, etc. This feature is good during winter months to keep pumps in top operating condition; by preventing them from gathering moisture while idle. This changing of pumps from one position to another is done at the main control panel. No trips to other stations or pump houses are necessary.



Receiver at Pump House

This receiver is located at the pump house. It is always in direct synchronization with the timer at the transmitter. Any trouble at the receiver in the pump control house will be transmitted to the main control panel by a five second alarm every sixty seconds; whereas, trouble at the transmitter sounds a continuous alarm. This difference in alarms saves time and provides instant information as to the location of the trouble.

Transmitter

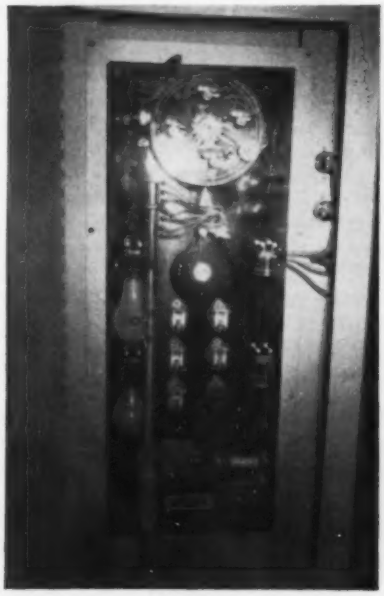
This transmitter operates from the reservoirs. It controls all pumps automatically, transmits the water level signal to the main station and also operates the recorder at the main station. The water level can be read at the transmitter at all times. Visible fuses (light globes) are used to protect leased wires and also provides protection for the transmitting instrument. A sixty second disc is used as a master timer for all equipment on the system. All controls are automatically reset in unison. Plug-in type relays are easily replaced.

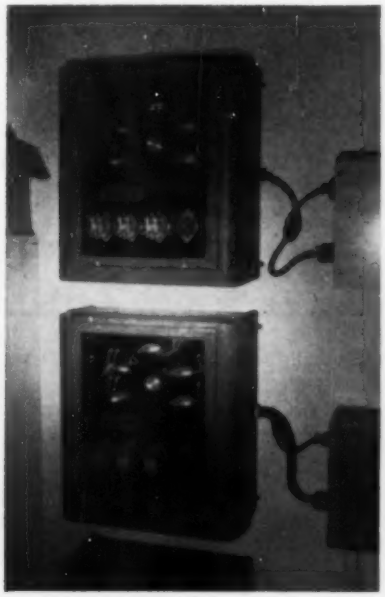
Delay Relay

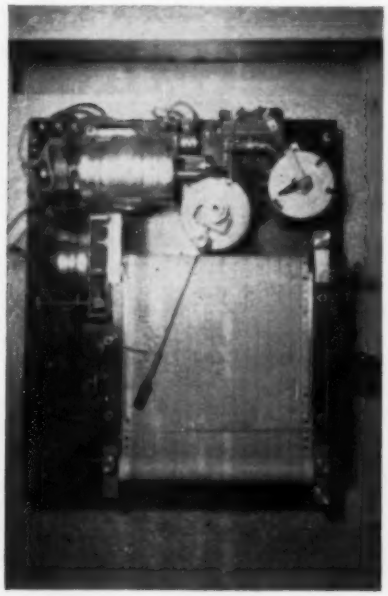
The delay relay was installed to provide protection against equipment becoming damaged. If a power failure occurs, this relay will not permit the pumps, which were on line at the time of power failure, to come back on line immediately upon restoration of power. First, the booster pumps will start two minutes apart; then the deep well turbine pumps will have time to go through a back spin, if they are not the ratched type, and then come on line fifteen to twenty minutes apart or at any desired time setting.

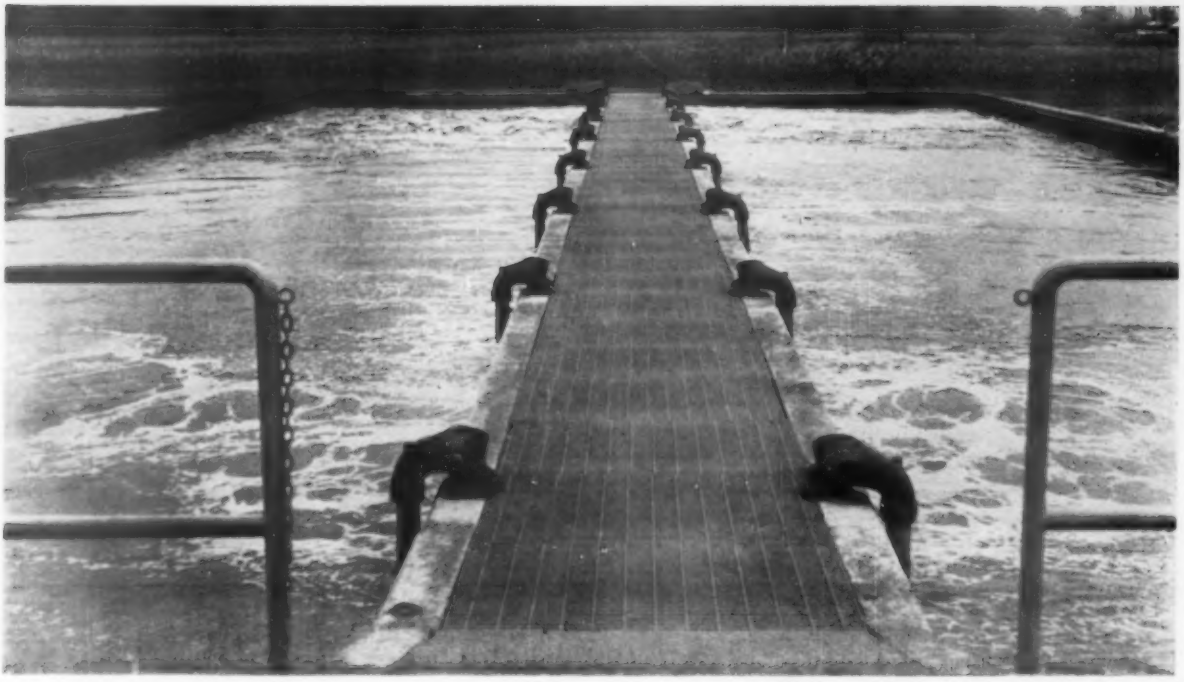
Recorder

This is one of the recording instruments at the main control station. Recordings are made on: water levels at reservoirs; number of pumps in running position; which pump is in operation; and trouble, if any, and its location. Water levels are maintained to within three inches of the overflow lines in all reservoirs and tower tanks. Provisions are also available here to manually start and stop pumps at well and booster locations throughout the entire water system. This feature makes it possible to test any of the pumps at any time.









AERATION tanks in activated sludge plant at Connersville, Ind.

Compressed Air Applications In Sewage and Water Works

From the aeration of sewage to zeolite softening in water works, compressed air plays a significant role

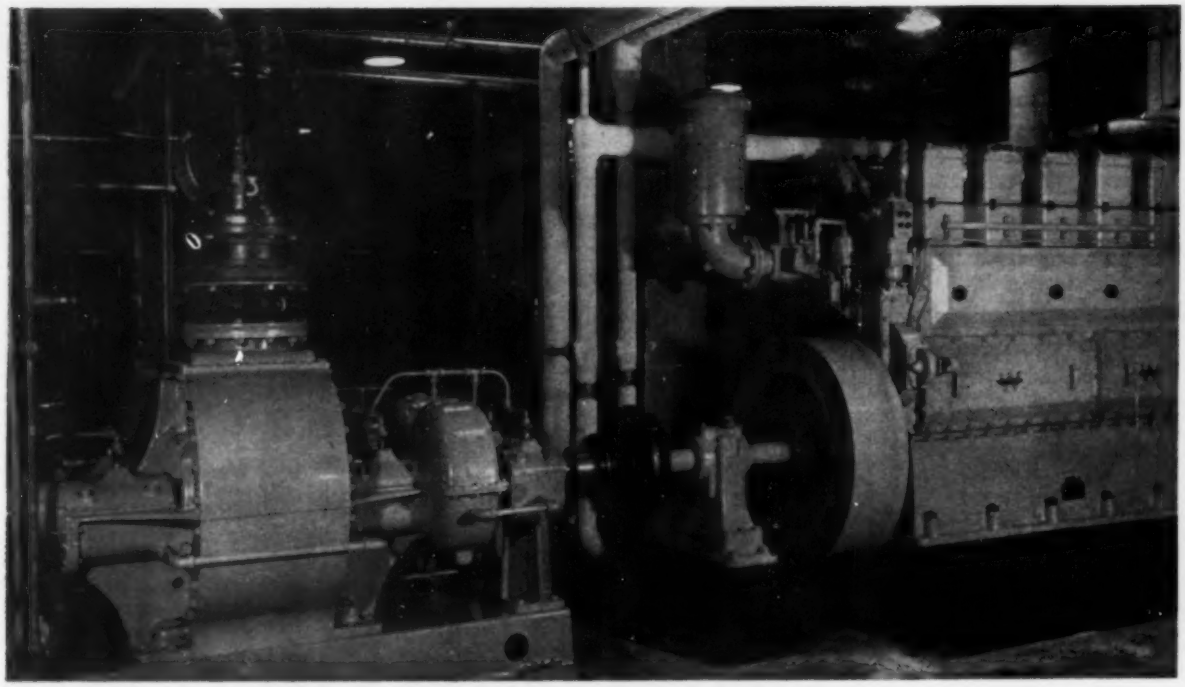
by J. L. HYLTON
Compressed Air and Gas Institute
Cleveland, Ohio

SEWAGE treatment requires compressed air at various pressures and in varying quantities throughout most of the processes employed. From the aeration of grit chambers through the pneumatic conveying of dried sludge, compressed air demonstrates its versatility. Regardless of the size or type of treatment plant considered, compressed air is a necessary ingredient in a multitude of applications.

Municipal water supply sources normally consist of wells, reservoirs, lakes or rivers; the water from each requires pretreatment. The principal objectives of pretreatment are to provide water not only free of harmful bacteria, but also of low hardness and with good taste. Pretreatment may consist of filtration, sedimentation, demineralizing, aeration, coagulation, softening and carbonation. Compressed air may be utilized to make water available from wells through air lift pumps or starting engine-driven pumps, in pretreatment processes, and in the laying and maintenance of mains to distribute the water for residential and industrial consumption.

Aeration

Aeration is the common method used to keep sewage and sludge aerobic and agitated in effecting stabilization by the activated sludge process. Aeration mixes the primary treatment effluent with the activated sludge, keeps the sludge in suspension, and supplies the oxygen required in the biological oxidation process. This process utilizes compressed air by discharging it through submerged diffusers of porous materials installed at or



LARGE rotary blower supplying air to sewage aeration tanks.

near the bottom of a tank under a 10- to 15-ft depth of sewage. The diffusers, in plate or tube form, are positioned in the tank in such a manner that a rotary or rolling motion is imparted to the sewage.

The amount of air required for suitable treatment is dependent on the strength of the sewage. Reported requirements are 0.5 to 1.5 cubic feet of air per gallon of sewage. Some engineers design for 1,000 cubic feet of air per day per pound of B.O.D. removed. The air pressure required varies from 6 to 9 psig.

Aeration without the production of an activated sludge, or "plain" aeration, is used quite often in the treatment of many types of industrial wastes. Waste reduction is accomplished mainly through a greater removal of suspended solids. Although not as efficient as activated sludge, plain aeration is used in the treatment of citrus cannery, oil refinery, dairy and pharmaceutical wastes. The air requirements again are dependent on the strength and type of waste being treated, but are comparable to those for activated sludge.

Aeration in water treatment is normally employed to oxidize dissolved iron or manganese and to reduce carbon dioxide and other gases. Aeration of water is accomplished by passing it through the air (as in a cascade), or by passing air in bubbles through the water. In most plants the latter method, of course, involves oil-free compressed air supplied by means of rotary blowers of the positive displacement type, although centrifugal blowers are used in large plants. Diffuser tubes or plates are used in the water tanks, with aeration for about 15 to 20 minutes being normal practice. Air requirements generally range from 0.05 to 0.10 cubic feet of air per gallon of water being treated.

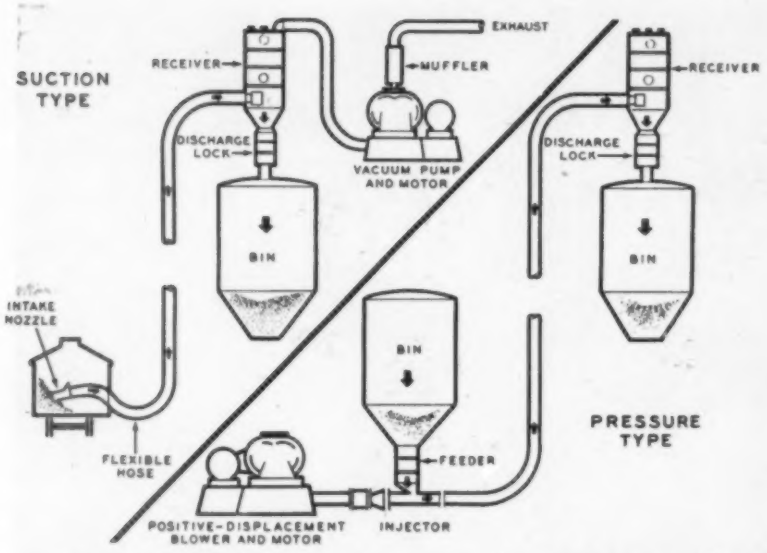
Grit Separation and Removal

Air diffusion or controlled aeration is often used to accomplish removal of grit from sewage in tanks or chambers similar to those used for activated sludge treatment. Grit removal in the early steps of treatment alleviates wear and operating troubles on equipment in subsequent treatment processes, and minimizes the accumulation of non-organic material in digestion tanks. Grit chamber diffusers are usually located higher than in the activated sludge tanks and above a sump permitting the grit to be collected and removed. The spiral motion of the sewage in the grit chamber rolls the grit towards and into the sump while organic solids are kept in suspension to pass on to the next treatment unit. Few organic solids are accumulated with the grit, due to the washing action of the sewage while the grit moves to the sump.

The recommended tank velocity is 1 to 2 feet per second. This velocity, imparted by air diffusers, moves the grit to the sump, where it drops out of the sewage, but keeps the organic solids in suspension. Air requirements vary with the size of the chamber; pressures of 5 to 8 psig usually are required. Some treatment plants uti-

Applications of Compressed Air in Water and Sewage Treatment

- Aeration of water, sewage and sludge
- Agitation and mixing
- Air displacement pumping
- Air lift pumping
- Backwashing sand filters
- Blowing filter cake
- Cleaning of material
- Draining of water mains
- Dust control
- Engine starting (gas and diesel)
- Engine turbocharging
- Flocculation
- Flotation
- Flushing of water mains
- Forced draft for incinerators
- Grit separation and removal
- Maintaining water pressure
- Odor control
- Operation of air motors
- Operation of pneumatic hoist
- Operation of remote and automatic controls
- Oxidation
- Painting of equipment
- Pneumatic conveying
- Power for maintenance tools
- Vacuum sludge filtration



PNEUMATIC conveying systems for use in water or waste treatment plants.

lize separate blowers for grit chamber air; others use air from the main air blowers, which also supply air to the aeration tanks. Grit removal is accomplished by screw conveyor, jet pump, clamshell bucket, or air lift.

Air Lift Pumping

The air lift is one of the oldest applications of compressed air, its principles having been discovered late in the 18th Century. It was first used to pump clear water from deep wells and began to be used for sewage treatment work about 1900. It is a device for raising liquids or waterborne solids through a vertical pipe, partially submerged in the liquid, by means of compressed air injected near the lower end of the pipe. The air introduced disperses through the liquid to create a column of mixture, filling the pipe to its full height, and weighing less than a liquid column of equal horizontal area on the outside, extending from the bottom of the pipe to the surface of the liquid. The unequal pressure created causes the column of mixture (liquid and air) in the pipe to rise and overflow the top. The high-lift air lift now in use on deep wells is claimed by its manufacturers to produce more water from a normal well at less cost than any other known method of pumping. The low-lift air lift is more suitable for handling waterborne solids and has found extensive use in sewage treatment plants.

Air lifts are simple in design and construction, requiring a minimum of repair. They need little space, can be accurately regulated to handle variable flows, will pass solids of large size, and can be constructed of materials resistant to acids and alkalis. They are well fitted for sewage treatment applications because of positive regulation of flow, the aeration effect of the compressed air on sewage or sludge, and the unimpairment of the settling qualities of sludge handled.

Air lifts are advantageous in water treatment plants because the power source is centralized and a group of wells at widely separated locations may be served by a single compressor and motor. If oil-free air is used the water is uncontaminated by the pumping medium, thereby possibly reducing filtration and/or purification requirements.

The air requirements for air lift installations vary with the size of installation and the submergence of the unit. One manufacturer lists air requirements of from 5 to 500 cfm.

Pneumatic Conveying

Large water and sewage treatment plants generally buy alum, soda ash, ferric sulfate and lime in bulk. These materials are usually unloaded to elevated bins by a conveyor system, either mechanical or pneumatic. Pneumatic conveyors involve the simple principle of blowing material through a tube with air pressure, or sucking material through a hose or tube by vacuum. They are clean, safe and economical. Air conveyors utilizing suction or pressure or a combination of both, are available to convey materials from car or truck to bin, and from storage bins to actual points of use such as feeders and mixers. Conveyor manufacturers will engineer the system and furnish all necessary appurtences, including feeders, filters, blowers and discharge locks.

Pneumatic conveying systems are offered to handle capacities ranging from 100 pounds to more than 100 tons per hour. A single system can handle many types of material without mixing or contamination. The system cleans itself after each transmission. Dust created in unloading and filling operations can be collected and exhausted to the atmosphere or collected for use.

Oil-free air is required for pneumatic conveyor service, the quantity being dependent on the rate of flow desired, the material being handled, the size of piping used, and the distance the material is to be moved. The average pressure system requires 6 to 9 psig; the average vacuum system, 10 to 20 inches Hg.

When dry chemicals are moved by conveyor belts, they are still fluffed by compressed air to prevent clogging and to facilitate handling.

Pneumatic conveyors are utilized by some of the larger municipal sewage treatment plants to convey dried sludge to loading docks or bagging operations.

Pre-Aeration

Use of the term "pre-aeration" in sewage treatment refers to the use of air ahead of the standard processes of primary or secondary treatment. Pre-aeration is accomplished by diffusing compressed air into the influent, resulting in better odor control, more efficient grease removal, higher dissolved oxygen content of raw sewage, and reduction of the organic load on subsequent treatment units. It has been used to maintain desirable effluent quality in an overloaded plant until such time as additional capacity is available through new construction.

Most authorities suggest pre-aeration detention time of 30 to 45 minutes at design flows, with a minimum air input of 0.1 cubic foot per gallon. Air requirements vary with the type of equipment used and the objectives to be accomplished.

Cleaning Sand Filters

Sand filters are commonly used where a more complete removal of suspended solids is desired than is possible by sedimentation or with trickling filters. These filters, utilizing sand or some other fine porous material, remove solids that are smaller or less readily settleable. The filter beds can be cleaned or reactivated quicker and more effectively by compressed air.

Agitation of the sand or filtering media with low-pressure air considerably reduces the cleaning time. This speed of filter reactivation is vital dur-

ing the summer months when water consumption is normally at a maximum. Air at from 8 to 10 psi is normally used for this application, supplied by separate blowers or taken from the plant air system. If plant air is used, pressure regulation is accomplished by the installation of valves on the air piping to the filter beds. Various types of equipment may utilize air pressure and force the air through the filter media; or may create a vacuum above the media and draw air through it.

Sludge Filters

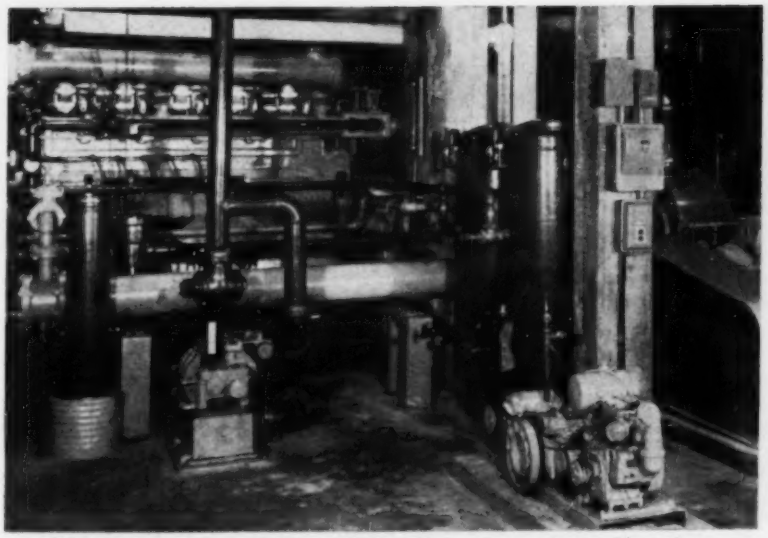
The conventional type of vacuum filter utilizes a drum partially submerged in a vat containing the sludge to be dewatered. The surface of the drum is covered with a filter medium, through which water is drawn from the sludge as the drum revolves through it. Solids are accumulated on the drum in a layer or cake, which may be ¼- to ⅜-inch thick. As the drum emerges from the sludge tank, the filter cake is further dewatered by drawing air through it with a vacuum pump. Stratification of sludge in the sludge tank may be prevented by agitating it by means of compressed air.

Separation of the cake from the filter medium is accomplished by the application of low-pressure air to the back of the medium or drum as it completes its revolution and is scraped into hoppers or onto conveyors.

Flotation

Industry has long utilized the process of flotation in the mining of coal and ores and in metal refining. Its use has recently been extended to wastes treatment, particularly in industrial waste treatment. Solids will separate from a liquid medium, either by settling due to gravity or by floating to the surface if they are lighter than the carrying liquid.

In wastes treatment, engineers and plant operators are faced with the problem of bringing solids to the surface of the wastes as rapidly and effectively as possible. Not only are they concerned with solids slightly lighter than water, but they also try to get those heavier than water to the surface where they can be skimmed or drained off. If these heavier solids can be combined with or attached to a material lighter than water, the new material or mixture will rise to the surface. This requirement is often met by the use of air. Diffused air is commonly blown into the waste, where the air bubbles attach themselves to the solids and carry them to the surface.



SMALL compressor providing starting air for a gas engine and/or other miscellaneous uses.

Plant and System Maintenance

Compressed air is an invaluable aid in plant and system maintenance, regardless of the type of municipal utility. Economics, safety and convenience dictate the use of compressed air as the source of power for maintenance tools and service operations. Repair shop tools, removing water from mains, earth tamping, paint spraying, ash and soot removal, rock drilling, and pavement breaking, all utilize compressed air from stationary or portable compressors.

Water mains up to 20 inches in diameter have been dewatered satisfactorily and quickly with 100-cfm compressors. This is particularly helpful in replacing old mains with new ones when water users and fire protection are involved.

Some municipalities utilize air pressure in flushing smaller water mains. Flusher-risers are installed in the mains at predetermined intervals and compressed air is put into the line through service connections. All water in the line is forced out through the riser by the air. Air at about 90- to 100-pound pressure is put through the empty main to loosen scale, rust, algae and other foreign matter. The main is then flushed with water at normal pressure to carry away the material loosened by the air. This alternate flushing with air and water continues until the water leaving the risers no longer carries any deposited material. This system is economical, eliminates many taste and odor complaints, and may increase materially the carrying capacity of older water lines.

Water-filled excavations and ditches may be pumped dry with small air lift pumps operated from portable compressors. Rocks and gravel are handled without fear of equipment breakage often experienced with centrifugal or reciprocating pumps.

Plant air or small rotary blowers are used in many sewage treatment plants to provide air for pneumatic hoist and lift operations. Swing-type diffusers are often pneumatically lifted from aeration tanks and grit chambers for cleaning and replacement of parts without emptying the tanks. Portable hoists are available with integral mounted blower that can be moved from one tank to another as required.

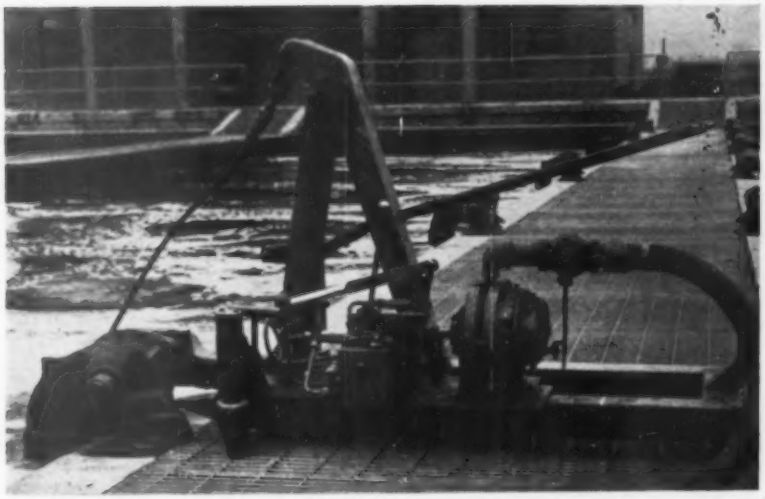
Miscellaneous Uses of Air

All water, sewage and industrial waste treatment plants require air for purposes not usually connected with the pumping or treatment of water and sewage. Engine starting, engine supercharging, boiler tube cleaning, soot blowing, control instrumentation, and pneumatic valves depend on compressed air for successful and efficient operation of modern plants. Compressed air enables many of these functions to be performed automatically with savings in manpower and equipment.

Bourbon tubes, diaphram pilot valves, and bellows activated by air permit plant operators to pick up pressure and volume changes in a system from a central control room. The sensitivity and dependability of compressed air has been significant in the use of air-controlled plant equipment, such as scales, chemical mixers, chlorinators, boiler feed pumps, driers, and deodorizers.

Versatility Unexcelled

Mention of a few of the many appli-



SMALL compressor providing starting air for a gas engine.

cations of compressed air in water and sewage treatment plants (see accompanying table) illustrates its versatility and importance in this field. The dependability, sensitivity, availability, convenience and relatively low cost of compressed air in this type of plant make it subject to ever-increasing use.

Careful consideration must be given, however, to the source of air supply for specific applications. Aeration, pneumatic conveying, agitation, instrumentation and control all require oil-free air with a minimum of moisture. Many of these applications require blowers and compressors to operate with a minimum of down time and maintenance. Space requirements, capacity and pressure needs, flexibility, accessory equipment required, and power consumption, are prime considerations in the specification and selection of blowers and compressors.

Blower and compressor manufacturers are anxious to assist in the selection of air supply equipment whenever possible, to insure the use of the best unit for the application at hand. But the equipment manufacturers are occasionally limited in the amount of assistance they can render by the quantity and quality of performance and process data submitted for blower and compressor selection. Consequently, the consulting engineers or municipal authorities share the responsibility for the selection of proper units. Adequate information insures the selection and use of blowers that will supply air economically, with minimum down time, and with sufficient capacity for future expansion.

Some States Supplementing Federal Aid in Sewage Treatment

Two important measures to further water pollution control in Vermont were enacted by the 1957 General Assembly. The first is an act making available through a $1 million bond issue, State grants of 20 per cent to municipalities for the construction of sewage treatment works. It is now possible for a Vermont municipality with 30 per cent available from the Federal Government under Public Law 600 to obtain as much as 50 per cent of the cost of constructing treatment facilities. The other legislation allows communities in Vermont to vote funds for sewage treatment plant construction on the basis of a *majority vote* instead of the two-thirds vote previously required by statute.

The Maine Legislature recently recently passed a bill appropriating $836,000 for use in the next two fiscal years to match local and federal funds for the construction of sewage and waste treatment plants and interceptor sewers. The measure limits state participation to 20 per cent of the total cost or two-thirds of the federal grant, whichever is less.

The Maryland Legislature authorized the creation of a state debt of $5,000,000 to supplement grants to municipalities by the Federal Government for the construction of sewage treatment facilities. The total contribution of federal and state monies under the provisions of this new law cannot exceed 40% of the total cost.

The only other state known to provide state-aid to municipalities to help finance the cost of sewage treatment facilities is Pennsylvania which adopted a law in 1953 providing for annual payments to cities that have expended money to acquire or construct sewage treatment plants since September, 1937.

In New Hampshire, a bill, very similar to that passed by the Vermont Legislature, was tabled by the N. H. Legislature until the next session.

Coagulant Aids Scrutinized by U. S. Public Health Service

Service Requested by A.W.W.A.

Following numerous inquiries from health agencies and at the request of the American Water Works Association, the Public Health Service has established a public advisory committee on coagulant aids. The Committee will advise the Public Health Service as to the safety of various coagulant aids offered or proposed for use in public water supply treatment.

Designated as the "Technical Advisory Committee on Coagulant Aids for Water Treatment," the group's function is to receive full information from producers and purveyors of these materials relative to their composition and toxicity, to review such information and to advise the Assistant Surgeon General and Chief Engineer of the Public Health Service as to the safety of these coagulant aids for use in treating drinking water. Recommendations of the Committee will be utilized by the Public Health Service in carrying out its statutory responsibility in the field of public water supplies.

Conclusions of the Committee are to be available to the Am. Water Works Assn., and also to any individual having responsibilities in the field of water supply.

At its first meeting at the Robert A. Taft Sanitary Engineering Center, Cincinnati, the Committee established operating procedures and policies to be followed in carrying out its work. Committee members are Dr. Herbert E. Stokinger, Public Health Service, Chairman; Dr. A. P. Black, University of Florida; Dr. David W. Fassett, Eastman Kodak Co.; Paul D. Haney, Black and Veatch Engineers; Dr. Robert A. Kehoe, Kettering Laboratory, and Dr. Richard L. Woodward, Public Health Service, Secretary.

Major manufacturers of coagulant aids have been notified of the committee's formation and will be invited to submit information on their products. Further information can be obtained from the Secretary of the Committee, c/o Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

GENOA'S sewage treatment plant digests garbage and sewage solids with aid of enzymes.

Enzymes Correct Digester Troubles and Eliminate Grease Problems

Observations and experiences at the Genoa, Illinois, sewage treatment plant

by PAUL R. CARLSON and PERRY CORNELL

Mr. Carlson is Chief Chemist of the Sanitary District of Rockford, Illinois, who as a "good neighbor" took an active interest in the trials of enzymic treatment of the Genoa sludge digester.

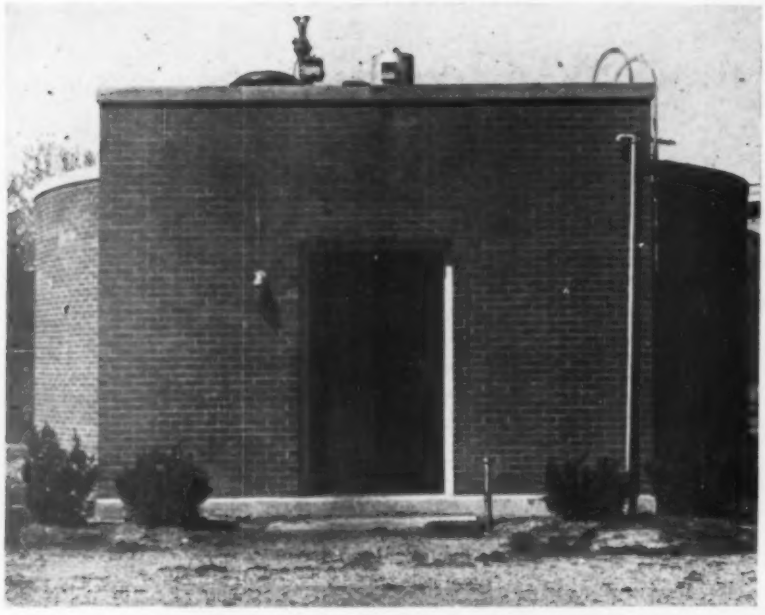
Mr. Cornell is Chief Operator of the Genoa sewage treatment plant and good friend of Rockford's helpful Carlson.

THE GENOA, Ill. sewage treatment plant consists of a bar screen, primary sedimentation, trickling filter, one heated digester and a sand sludge drying bed. The digester is 30 feet in diameter by 20 feet side wall depth, equipped with a PFT floating cover, and PFT heat exchanger unit, utilizing gas and oil for fuel. A temperature of 95 deg. F. is maintained in the digester. Unfortunately no gas meter is available for measuring gas production. The sewage is mainly domestic from a connected population of roughly 2500.

Garbage an Added Loading

Since January of 1955 all garbage from the city has been trucked to the plant, being picked up once weekly in winter and twice during summer. This garbage, including paper used for wrapping, is ground and diverted to a sump to which water is added to form a slurry. This, the raw sludge pump can successfully pump to the digester. Approximately 4,500 pounds of garbage weekly is being pumped to the digester on Tuesdays during the winter months, and in summer is divided between Tuesday and Friday, the total weekly poundage being somewhat greater in summer.

During 1955 the digester operated



GENOA's heated digester with floating cover.

satisfactorily, volatile acids in the digester ranging from 900 p.p.m. to 1,300 p.p.m. and p.H. from 6.8 to 7.1. A scum layer was gradually forming but the digested sludge dried quite well on the sand drying beds. Four to five hours after addition of garbage to the digester, gas production increased tremendously, so that on Tuesday evenings and all day Wednesdays there was an abundance of gas available for heating purposes. The rate of gasification then decreased slowly until practically no gas was available over the week-ends.

Then Trouble

The scum layer continued to increase in thickness and drying qualities of the sludge decreased during 1956. In September 1956, when it became necessary to burn more fuel for digester heating, it was observed that the large amount of gas produced on Tuesday began to decrease rapidly and by late Wednesday afternoon, the gas supply had dwindled to a condition where more oil than gas was being burned. The percentage of oil used increased until oil was burned exclusively over the week-ends and until Tuesday afternoon again. Digested sludge applied to the sand drying-beds exhibited a sour odor, attracted flies and did not dry well. On inspection, a heavy thick grey scum layer was observed in the digester. It varied in thickness from 3 to 3½ feet. In December 1956, the scum layer measured from 3½ to 4 feet in thickness and it was necessary to use a 2 x 4 timber to break through the solids to insert a hose used for supernatent withdrawal. This scum layer extended over the entire digester and what gas was produced was escaping through channels in the scum. To all intent and purpose digestion was at a stand-still and the digester was rapidly approaching a condition where it would become necessary to dump the entire contents and make a new start.

A Test for Enzymes

A decision to try enzymes was made. Consequently, beginning December 21, 1956, one pound of 'Sea-Cal" Formula M-200 was added to the digester each day for 10 days. It was introduced through the raw sludge pump during a regular sludge pumping. One pound weekly, was added during the weeks of January 4, 11, 18, 25, and February 1st. Beginning February 5th two pounds weekly were added on February 5, 8, 12, 15, 19, 22, 25, 28, and March 5, 8, 12, 15, 19, and 22.

On February 5th the scum layer was examined and found to have softened completely and to the extent that the 2 x 4 timber was not needed, the syphon hose going though the solids very readily. Gasification had picked up and the sludge which had been greyish yellow in color had changed to the familiar black and with a tarry odor. This well digested sludge was observed over the entire outside circumference of the digester.

The scum layer was again examined March 8th and had decreased 20 inches in thickness and well digested sludge was present under a good share of the cover, except for a 15 foot diameter circle at the center of the digester, where the fresh garbage is discharged.

Effects Noted

Volatile acids in the digesting sludge had remained high before the administration of enzymes, reading 1,720 p.p.m. (12-13-56) and 1,640, (12-18-56). Six days after the first application of enzymes, the volatile acids reading was 1,520 p.p.m. and on March 7th, the reading was 1,420 with a reading of only 1,060 p.p.m. recorded on March 23. The pH of the sludge improved from a low of 6.4 in December to a satisfactory 7.2.

Gas production in the digester markedly increased, cutting down the amount of oil burned weekly from an average of 100 gallons per week, before addition of enzymes, to 45 gallons per week for the weeks of March 3rd and 10th. Enough gas is now being produced to supply 75% to 80% of the fuel needs of the heat exchanger. Unfortunately, large amounts of gas are escaping around the edges of the digester cover.

Approximately 5,000 gallons of digested sludge was withdrawn from the digester March 1st and hauled by tank wagon to a nearby farm where it was applied to the land. This sludge had all the characteristics of well digested sludge, being a good black with a tarry odor and pH of 7.8. On observation three weeks later it had dried very well. Formerly sludge disposed of in this manner had not dried properly and was prevented from drying because of the high grease content, still present due to poor digestion.

Cost of Treatment Justified

A total of 29 pounds of the enzyme preparation has been added to the digester from the starting date of December 21, 1956 to the present date March 23, 1957. At a cost of $8.00 per pound the total expenditure has amounted to $232.00. It is the opinion of the authors that this is negligible compared to the cost of cleaning the digester, which task in itself would have been a very tough and disagreeable job. Also, in this particular instance, the savings in cost of oil for fuel will almost pay the cost of the "Sea-Cal" enzyme preparation used.

Enzymes will continue to be used for another three months, using about 7 pounds per month until the 50 pounds purchased have been used. From results already observed it is felt that the scum layer will be kept

under control and a well digested sludge be produced. Continuing studies will be made to obtain a complete picture of the Genoa digester operation.

Later Information

As of this writing (May 15, 1957) the condition of the digester has continued to improve despite much larger loadings of garbage, which loadings in recent weeks have jumped to 12,000 to 13,000 pounds weekly. Sludge was drawn from the digester May 3rd and exhibited the following physical properties; pH 7.2; dry solids 5.60%, volatile solids 56.2% and volatile acids 1220 p.p.m. Observation by one of us (Cornell) of the sludge withdrawn was that it was the heaviest and best looking sludge since the plant started operation. Gasification has continued to increase and very little gas is escaping at the digester cover edges. The sludge has softened and liquified to form a good seal. The thickness of the scum layer is approximately 8 to 10 inches near the center of the digester. Due to the heavy loadings of garbage, 2 lbs. weekly of the enzymes will continue to be added.

Current Operations

As of now (Sept. 12, 1957) "Sea-Cal" M-200 has been added at the rate of 2 lbs. per week throughout the summer and results have continued to improve. The scum layer has disappeared and a good liquid sludge has formed a good seal around the outer diameter of the cover, thereby stopping the loss of gas to the atmosphere. Since May first until now (Sept. 12) something less than 100 gallons of fuel oil have been needed for heating the digester. This compares with the consumption of 100 gals. per week before the use of enzymes. Sludge has been drawn regularly and cracks and dries beautifully, whether on the drying beds or on a farmer's land. The sludge sample of Sept. 12th showed a volatile acids content of only 720 p.p.m. and a pH of 7.2. This must be considered as exceptionally good when considering the large load of garbage which is being added to the digester twice weekly.

Something New

One of us (Cornell) had been observing that the distributor nozzles on the trickling filter were clogging because of grease and slime deposits. Experimentally, one pound of "Sea-Cal" M-200 added weekly to the wet-well feeding the filter has cleaned these nozzles up very well. This wet well, 22' x 6' x 4' water depth, receives the primary effluent which is then pumped to the trickling filter. The wet well was observed to have a grease or scum layer of about 5" to 6" in thickness and needed cleaning. Experimentally, 3 lbs. of M-200 was added to the well which was allowed to stand idle 5 days. On inspection all grease and scum had apparently been digested or liquified, and the concrete walls were perfectly clean.

Appropriate Recognition of Veteran Water Works Leader

To South Carolinians this will not be news. To many other of our readers it will be.

A veteran water works leader, Guy H. White, was retired as Superintendent of Water at Columbia, S. C. in 1955. Since then he was served the Water Department as engineering consultant, making a total of 49 years of service to the City of Columbia up to the date of his complete retirement at the close of 1956.

The City has since named the Columbia Filtration Plant and Pumping Station the Guy H. White Water Plant in recognition of his long and valued service.

Guy White has always kept abreast of developments in water supply practices and has been a "sparkplug" in water works activities. He was, in fact, the "father" of the S.C. Water and Sewage Works Short School. He was a charter member of the S.C. Water Works Assn. and the Tri-State Water Works Assn., which later became the Southeastern Section of A.W.W.A. The latter he served as Chairman and, later, as National Director (1940-1943). He was one of the very earliest recipients of the Geo. W. Fuller Award (1938) and in 1955 he was made a Life Member of A.W.W.A.—the "badge" of seniority and a 30-year membership.

Engineer Earnings—

How Do YOU Stand?

Young engineers, chemical engineers, and engineers in education have achieved the largest gains in total earnings over the period 1952-'56, and engineers employed by Federal agencies have made the smallest gains.

These are some of the findings drawn from the latest "Professional Engineers' Income and Salary Survey" published by the National Society of Professional Engineers.

The competition among employers for recently graduated engineers is reflected in the percentage increase in earnings for this group. Engineers at Grade 3, a pre-professional level, were found to have an increase in earnings of 28 per cent from 1952-'56, a higher increase than was noted in any of the other grades.

Chemical engineers had a median earning total of $11,000 for 1956. Civil engineers had the lowest median earnings of any of the major branches with a figure of $8,750. Other median earning figures for 1956 were electrical $9,460; mechanical $9,780; mining and metallurgical, $10,000.

The greatest increase in earnings, dollar-wise, was reported by engineers connected with educational institutions, with those engaged primarily in teaching reporting the greatest percentage-wide increase. Engineers in public utilities reported the second highest dollar-wise increase, while engineers in industry reported the third highest.

A statistical breakdown on over-all earnings of engineers in 1956 shows that 90 per cent of those replying to the survey questionnaire earned at least $6,390, as compared with $5,570 for 90 per cent in 1954. The 1956 survey also shows that 10 per cent of those replying earned at least $19,860. In between these two groups, the 1956 survey shows 75 per cent of the respondents earning at least $7.510; 50 per cent earning at least $9,490, and 25 per cent earning at least $12.840.

Copies of the 1956 "Professional Engineers' Income and Salary Survey" may be obtained for $1 from the National Society headquarters, 2029 K St., N.W., Washington 6, D. C.

Today as Yesterday

"You can not help men permanently by doing for them what they could, and should do for themselves."—*Abraham Lincoln*

Stop These Efficiency Stealers ! ! !

An Open Letter to Water and Sewage Superintendents on Personality Problems

Dear Bill—

Did you ever say to yourself—this is a day when I should have stayed in bed; this is a day when everything I do or everything my staff does turns out wrong. Do these days happen to you very often? Have you resigned yourself to consider this a normal situation?

Well, a fellow I know says you shouldn't take them as normal; and what's more, he says, there are many things you can do to overcome the situation. The trick is to get your own personal operations in order and under control. For example, there are a number of sly thieves that rob us of our efficiency. By battling these things, we can improve the situation and help reduce these off days.

What are these efficiency robbers?

Here are some of the more common ones and what we can do about them. Each in itself seems unimportant but two or three taken together can in a single day nullify a week of good productive effort in your department.

Headaches—This difficulty is not a minor inconvenience a good manager learns how to handle with a few pills! Find the medical causes from your doctor—take the steps to be rid of them forever. They damage before, during and after pain-killing pills are taken.

Tiredness—No one can be thoroughly efficient when he is tired. If we get tired before the day is even well underway something is wrong. Perhaps the trouble calls for medical treatment. Maybe it also calls for better scheduling of our work. Too many individuals set up heavy loads early in the day for they feel these can be best tackled while they are "fresh." Spreading them out is time proven a much better procedure.

Irritability with one's work—This little efficiency thief not only saps ability but causes the individual to disrupt the efficiency of other people on the staff. A more relaxed attitude toward one's work—taking time out to take it easy now and then—better planning of the job—each of these can reduce irritation.

Decrease of interest in the job—Many a manager plans carefully to hold the interest of his staff in their work for he well knows that without such interest any individual is always less efficient. He completely overlooks the same effect upon himself. Stand back and take a fresh look—talk it over with an older friend—new attitudes will come to light that will help to revive this interest.

Irritation with "higher ups"—No one is immune from this efficiency thief; it can happen in the best regulated departments at any time. Usually it is brought on by misunderstanding either on our own part or on the part of those higher ups. Blow off steam to yourself and to help cast out this little robber. Keep brooding over it and it will remain to do more and more damage. Developing the flexible personality which permits such irritations to bounce away without penetrating our inner consciousness is a sure fire method of handling this particular demon.

Loss of patience with others—Here is something the good manager guards against constantly before damage is done.

Forgetfulness—Any person's job can always be made much more difficult when forgetfulness sets in on him. It virtually ruins top productive ability of the people who work under and with him. It's both a mental and physical problem. Usually the causes are of a personal nature. Some times we have to learn harder concentration to counteract it.

Blueness—Many personal problems can cause such a feeling. We tolerate it because we feel the damage is slight. Actually the reverse is true for this dejected condition robs everyone of better than half his normal efficiency. Maybe it takes great self discipline but we have to learn to leave personal things outside the job.

Sleeplessness—Too much bridge, too many parties, too much work—these and many other things rob us of the very necessary sleep we need to be at top efficiency on our job. Often it is simply failure on the part of the individual to recognize that as he grows older his physical and mental self needs more and more relaxed sleep.

The feeling of failure—Even though we occupy a top spot in our profession this efficiency robber will sneak up on us from time to time. On such occasions it is a good idea to stop work and do a little self appraisal—adding up the assets and balancing them against those possessed by others we know.

Decline in mental alertness—It never pays to ignore or try to bluff through this situation. When we become aware it exists or even suspicion that something of this nature is present it is time then and there to search out causes and do something toward eliminating them. Today's job calls for more and more mental alterness on our part—not less.

Nervousness—This is a terrible efficiency thief for it usually brings along a host of bad cousins. It should never be tolerated. At the first sign it calls for medical examination for the causes and their immediate remedy. The nervous individual never does the job properly—and decreases the efficiency of everyone with whom he comes in contact.

Recognizing all of these negative factors in our personality keeps stress while on the job at the lowest possible point. Taking time out to eradicate them not only assures us of an increase in efficiency on our own part but enables us to get more out of the people on out staff every working day!

Yours,

*Jack**

* Ed. Note: "Jack," in this instance, is Ernest W. Fair, a field editor for leading business and industrial magazines, who resides in Boulder, Colo.

"from Chicago"

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Meetings Scheduled

1957

SEPTEMBER						
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Nov. 11-13—Jacksonville, Fla. *(Roosevelt Hotel)*
FLORIDA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Ralph H. Baker, Jr., State Board of Health, P. O. Box 210, Jacksonville 1, Fla.

Nov. 11-13—Raleigh, N. C. *(Hotel Sir Walter)*
NORTH CAROLINA SECTION, A.W.W.A., AND NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., Joint Meeting, Secy., Wilbur E. Long, Jr., 1615 Bickett Blvd., Raleigh, N. C.

Nov. 11-15—Cleveland, Ohio *(Public Auditorium)*
AMERICAN PUBLIC HEALTH ASSOCIATION, 85th Annual Meeting, Exec. Director, Dr. Reginald M. Atwater, 1790 Broadway, New York 19, N. Y.

Nov. 15—Columbia, S. C. *(Jefferson Hotel)*
SOUTH CAROLINA WATER & SEWAGE WORKS ASSN., Secy., W. G. Crosby, State Board of Health, Columbia, S. C.

Nov. 18-22—Stillwater, Okla. *(Oklahoma A & M College)*
OKLAHOMA WATER & SEWAGE SHORT COURSE, Prof. Quintin B. Graves, Oklahoma A & M College, Stillwater, Okla.

Nov. 20-22—Allerton Park, Ill. *(University of Illinois)*
SIXTH ANNUAL UNIVERSITY OF ILLINOIS WATER WORKS MANAGEMENT SHORT COURSE, Chairman, Dr. T. E. Larson, Illinois State Water Survey, Urbana, Ill.

Nov. 21—Boston, Mass. *(Hotel Statler)*
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

Dec. 1-6—New York, N. Y.
AMERICAN SOCIETY MECHANICAL ENGINEERS, 29 West 39th Street, New York, N. Y.

Dec. 8-11—Chicago, Ill. *(Conrad Hilton Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Annual Meeting, Secy., F. J. Van Antwerpen, 25 West 45th Street, New York 36, N. Y.

Dec. 12—Augusta, Maine.
MAINE WATER UTILITIES ASSN., Secy., Gerard F. Laurin, 89 Western Ave., Augusta, Maine

Dec. 19—Boston, Mass. *(Hotel Statler)*
NEW ENGLAND WATER WORKS ASSN., Secy., Joseph C. Knox, 73 Tremont St., Boston, Mass.

1958

Jan. 23-24—New York City, N. Y. *(Hotel Belmont-Plaza)*
NEW YORK SEWAGE & INDUSTRIAL WASTES ASSN., Exec. Secy., Ralph C. Sweeney, State Dept. of Health, 21 N. Broadway, White Plains, N. Y.

Feb. 5-7—Indianapolis, Ind. *(Sheraton-Lincoln Hotel)*
INDIANA SECTION, A.W.W.A., Secy., Chester H. Canham, 3517 Manor Court, Indianapolis 18, Ind.

Feb. 24-28—Chicago, Ill. *(Hotel Sherman)*
AMERICAN SOCIETY OF CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 West 39th Street, New York 18, N. Y.

Mar. 2-7—College Station, Texas *(Texas A & M College)*
TEXAS WATER & SEWAGE WORKS ASSN., Secy., V. M. Ehlers, 2202 Indian Trail, Austin 3, Texas.

Mar. 12-14—Atlantic City, N. J. *(Traymore Hotel)*
NEW JERSEY SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Michael S. Kachorsky, P. O. Box 68, Manville, N. J.

Mar. 12-14—Salina, Kansas *(Lamer Hotel)*
KANSAS SECTION, A.W.W.A., Secy., Harry W. Badley, Neptune Meter Co., 119 W. Cloud Street, Salina, Kansas.

Mar. 20-22—Missoula, Montana *(Florence Hotel)*
MONTANA SECTION, A.W.W.A., Secy., Arthur W. Clarkson, Asst. Director, Div. of Env. Sanitation, Montana Board of Health, Helena, Mont.

Mar. 23-26—Atlanta, Ga. *(Dinkler-Plaza Hotel)*
SOUTHEASTERN SECTION, A.W.W.A., Secy., N. M. deJarnette, Engr., Div. of Water Pollution Cont., State Dept of Health, 309 State Office Bldg, Atlanta 3, Ga.

Mar. 24-26—Fayetteville, Ark. *(Hotel Not Listed)*
ARKANSAS WATER & SEWAGE CONFERENCE, Secy., C. W. Oxford, University of Arkansas, Fayetteville, Ark.

Mar. 26-28—Schenectady, N. Y. *(Van Curler Hotel)*
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, Rensselaer-Ludlow Valve Co., 11 W. 42nd St., New York 36, N. Y.

Mar. 26-28—Chicago, Ill. *(LaSalle Hotel)*
ILLINOIS SECTION, A.W.W.A., Secy., Dewey W. Johnson, Cast Iron Pipe Res. Assn., 122 S. Michigan Ave., Chicago 3, Ill.

Apr. 16-18—Lincoln, Neb. *(Cornhusker Hotel)*
NEBRASKA SECTION, A.W.W.A., Secy., John E. Olsson, 408 Sharp Bldg., Lincoln, Neb.

Apr. 18—Harrisburg, Pa. *(Penn-Harris Hotel)*
ANNUAL CLEAN STREAMS CONFERENCE, Secy., R. V. Wall, Penna. State Chamber of Commerce, State Chamber Bldg., Harrisburg, Pa.

Apr. 20-25—Dallas, Texas *(Memorial Auditorium)*
A.W.W.A. CONVENTION, Secy., Harry E. Jordan, American Water Works Assn., 2 Park Ave., New York 16, N. Y.

Apr. 23-26—Stockton, Calif. *(Hotel Stockton)*
CALIFORNIA SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Robert J. Barletta, 719 South Loara Street, Anaheim, Calif.

Apr. 28-29—Roanoke, Va. *(Hotel Roanoke)*
VIRGINIA INDUSTRIAL WASTES & SEWAGE WORKS ASSN., Secy., O. J. Hand, c/o Hercules Powder Co., Hopewell, Va.

May 15-17—Spokane, Wash. *(Davenport Hotel)*
PACIFIC NORTHWEST SECTION, A.W.W.A., Secy., Fred D. Jones, Asst. Supt., Water Dept., Rm. 306, City Hall, Spokane, Wash.

May 15-17—Tucson, Ariz. *(El Conquistador Guest Hotel)*
ARIZONA SECTION, A.W.W.A., and ARIZONA SEWAGE & WATER WORKS ASSN., Joint Meeting, Secy., Stanford I. Roth, 813 E. Jefferson, Phoenix, Ariz.

June 1-4—Toronto, Canada *(Royal York Hotel)*
CANADIAN SECTION, A.W.W.A., Secy., A. E. Berry, Ontario Water Resources, Parliament Buildings, Toronto, Ontario, Can.

June 18-20—Toledo, Ohio *(Commodore Perry Hotel)*
OHIO SEWAGE & INDUSTRIAL WASTES TREATMENT CONFERENCE, Secy., Cleamon E. Lay, 301 Ohio Departments Bldg., Columbus 15, Ohio

June 22-25—Philadelphia, Pa. *(Bellvue-Stratford Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, 50th Anniversary Meeting, Secy., F. J. Van Antwerpen, 25 West 45th St., New York 36, N. Y.

June 23-25—Charlevoix, Mich. *(Charlevoix Beach Hotel)*
MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSN., Secy., Donald M. Pierce, Michigan Dept. of Health, Lansing 4, Mich.

June 23-27—Portland, Oregon *(Hotel Multnomah)*
AMERICAN SOCIETY OF CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 West 39th Street, New York 18, N. Y.

June 25-27—Erie, Pa. *(Hotel Lawrence)*
PENNSYLVANIA SECTION, A.W.W.A., Secy., L. S. Morgan, Div. Engr. State Dept. of Health, Greensburg, Pa.

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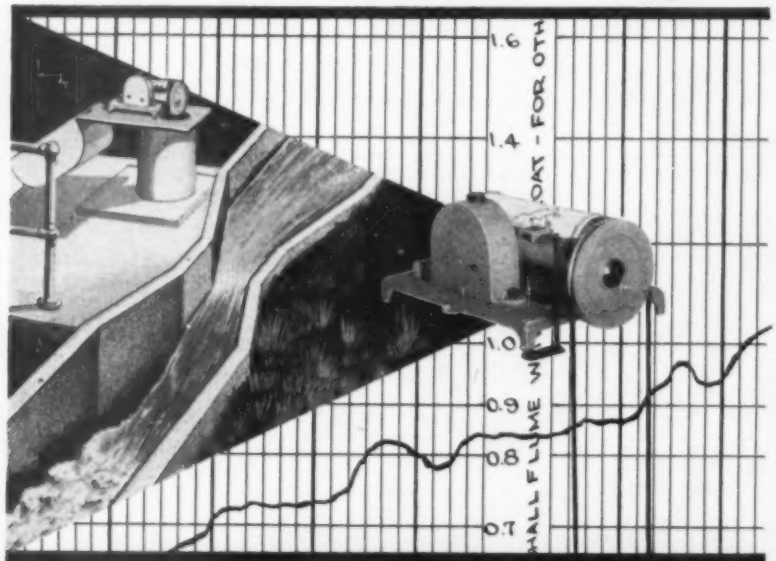

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W&SW EQUIPMENT NEWS

Non-Clog Sump Pumps
1101

C. H. Wheeler Manufacturing Co., Philadelphia, Pa., has available a completely new re-designed line of non-clog sump pumps. The new pumps are manufactured in 3 and 4 in. sizes. Capacities range from 20 to 1,100 gpm. Heads go as high as 160 ft.

The new design features a split motor stand, allowing easy access to motor, pump shaft and bearings. After removing only four bolts, motor can be lifted off the pump without disturbing the piping.

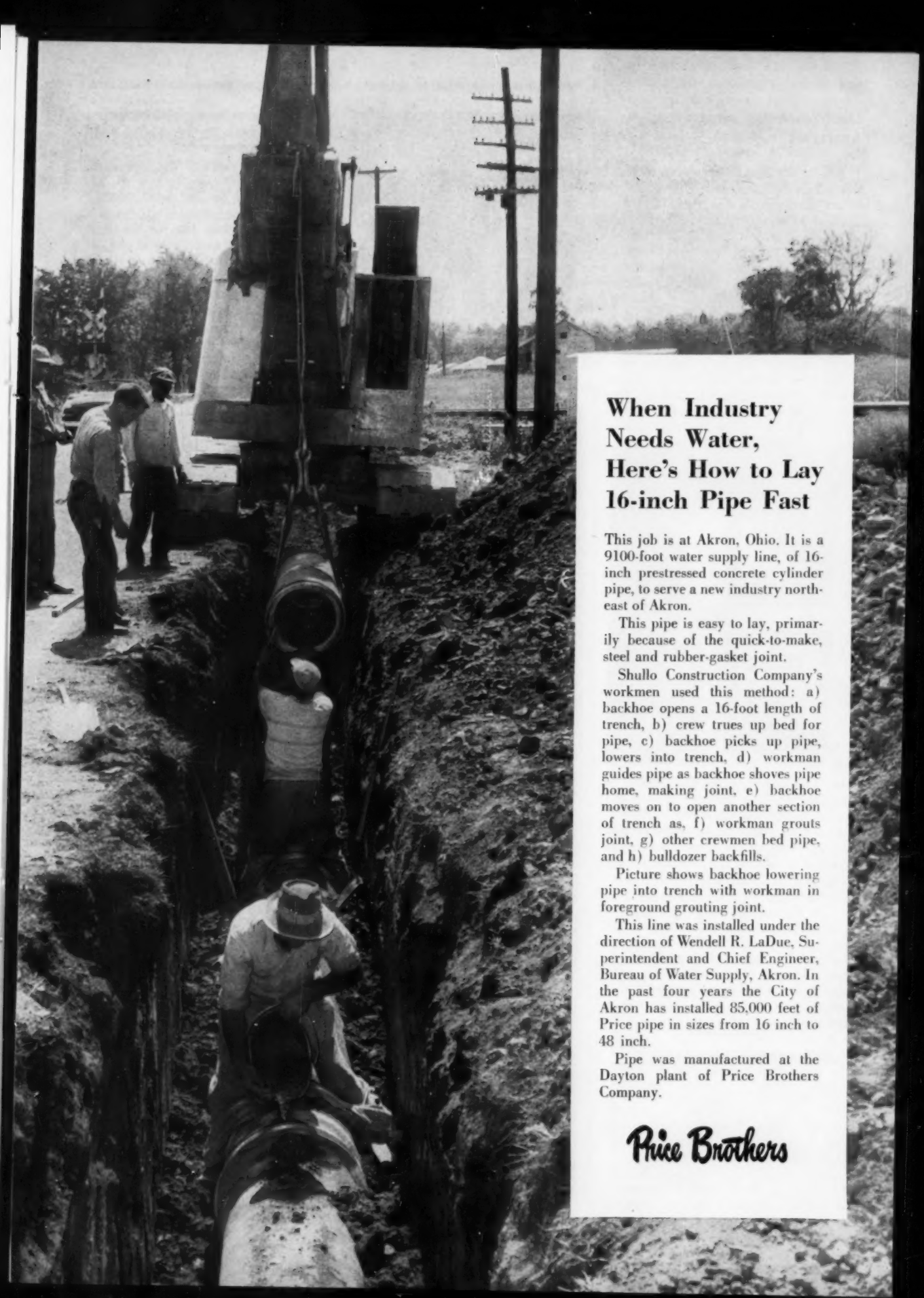
Self lubricating bearings are used to eliminate lubrication problems. Both the double sealed ball thrust bearings above the floor plate and intermediate sleeve bearings used on the shaft when the sump depth exceeds 4½ ft. will operate for the life time of the pump without outside lubrication.

The pumps are equipped with grease packed stuffing boxes, which eliminate the need for repacking and consequent down-time. Rotating parts are statically dynamically balanced.

Transistorized Audio-Tone Transmission For Control Systems
1102

Builders-Providence, Inc. Div. of B.I.F. Industries, Inc., Providence, R. I., has announced that centralized supervisory control systems can now utilize the many distinct advantages of transistorized audio-tone transmission. Up to 18 functions, telemetering and controlling, may be transmitted over a single pair of private or leased wires, carrier current, radio or microwave mediums. This type of transmission has proved ideal in economically centralizing the control of remote functions found in both municipal and industrial applications . . . for telemetering such quantities as pressure, temperature, level, flow, turbidity, chlorine residual, pH, conductivity, and many others.

Ease of assembly, interchangeability, installation, and system expansion are features of the compact, completely transistorized, "plug-in" design of the power supply, transmitters, and receivers. The 100% transistor circuits eliminate costly tube power consumption and maintenance. Specially developed circuit design eliminates frequency interference on adjacent channels.



When Industry Needs Water, Here's How to Lay 16-inch Pipe Fast

This job is at Akron, Ohio. It is a 9100-foot water supply line, of 16-inch prestressed concrete cylinder pipe, to serve a new industry northeast of Akron.

This pipe is easy to lay, primarily because of the quick-to-make, steel and rubber-gasket joint.

Shullo Construction Company's workmen used this method: a) backhoe opens a 16-foot length of trench, b) crew trues up bed for pipe, c) backhoe picks up pipe, lowers into trench, d) workman guides pipe as backhoe shoves pipe home, making joint, e) backhoe moves on to open another section of trench as, f) workman grouts joint, g) other crewmen bed pipe, and h) bulldozer backfills.

Picture shows backhoe lowering pipe into trench with workman in foreground grouting joint.

This line was installed under the direction of Wendell R. LaDue, Superintendent and Chief Engineer, Bureau of Water Supply, Akron. In the past four years the City of Akron has installed 85,000 feet of Price pipe in sizes from 16 inch to 48 inch.

Pipe was manufactured at the Dayton plant of Price Brothers Company.

Price Brothers

Quantichem Colorimetric Analyzers

1103

Milton Roy Co., Philadelphia, Pa., has announced the availability of their new Quantichem automatic analyzers. Backed by more than three years of intensive research and field studies, the new instruments will continuously analyze water for total hardness or silica concentration. Each analysis is on a fixed time cycle with the results recorded on a separate unit that may include alarms or control devices.

The analyses are based on the effects silica or hardness-causing calcium and magnesium ions have on specific reagents which change the amount of light that a given volume of sample solution will absorb or transmit. The difference in the amount of transmitted light through a zero cell and a test cell is measured photoelectrically, and because the difference is proportional to the concentration of silica or hardness, the instruments are calibrated to read in units of concentration.

The silica analyzer has a range of 0 to 0.05 ppm. The standard ranges for the total hardness analyzers are 0-3 and 0-5 ppm with a sensitivity of 0.03 and 0.05 ppm, respectively, calibrated as calcium carbonate. Other ranges are available to meet special application.

Fabricated Flow Nozzle

1104

Burgess-Manning Co., Penn Instruments Div., Philadelphia, Pa., has developed a new fabricated flow nozzle that is lighter, less expensive, easier to handle and is non-corrosive.

According to the company, the nozzle, which is about one-fifth the weight of forged steel, can be delivered in less than half the time required for forged steel. It is made to the ASME fluid flow measurement code.

Although manufacturing costs studies have not yet been completed, experience so far has indicated that the cost of fabricated nozzles will be considerably less than that of the steel units, with costs decreasing in proportion to the size of the nozzle above 10 in. The studies also indicate that cost of fabricated nozzles below 8 in. will be about the same as that of steel nozzles.

The company so far has manufactured the new nozzles up to 24 in. and has made quotations on 30-in. units.

WOOD
GATE VALVES

First Choice for Extreme Reliability

Because of their inaccessibility underground, repairs to gate valves are always time-consuming, expensive, and a source of annoyance. And interruptions in service while repairs go on are hazardous for the community.

For these reasons, R. D. Wood Gate Valves are designed to function for generations no matter what the conditions. They are rugged in construction, fully bronze mounted, and tested to 300 lb. hydrostatic pressure. Designed for working pressures conforming to AWWA specifications.

Available with mechanical joint or flange-type pipe connection

SIMPLE IN DESIGN

Only three moving parts—a spreader and two discs which are free to revolve their complete circumference while being raised or lowered. Gates are lifted entirely clear of valve openings, providing unobstructed flow.

Titanium Tubing Featured in Improved Chlorinators

1105

Wallace & Tiernan, Inc., Belleville, N. J. and Superior Tube Company, Norristown, Pa., have developed a Titanium tubing that, when teamed up with plastics combats corrosion in the new W&T chlorinator for water treatment. The Quality - Quantity Chlorinator is a new type of chlorination system, its name is derived from the fact that it automatically adjusts the chlorine feed rate to changes in the chlorine demand (quality) as well as the flow (quantity) of the water being treated.

Most of the titanium tubing is in the form of short nipples for connecting flexible vinyl plastic tubing to acrylic blocks. Both the plastic and the titanium come in constant contact with a wide variety of chemicals, including salt solutions, wet chlorine and potassium iodide. Titanium was selected for the nipples because of its remarkable resistance to all of the corrosive elements encountered.

Although the amount of titanium tubing required for each chlorinator is quite small, it contributes significantly to the satisfactory performance of the equipment.

R. D. Wood Gate Valves also now available with O-Ring Stuffing Box seal when specified.

Made by

R. D. WOOD COMPANY

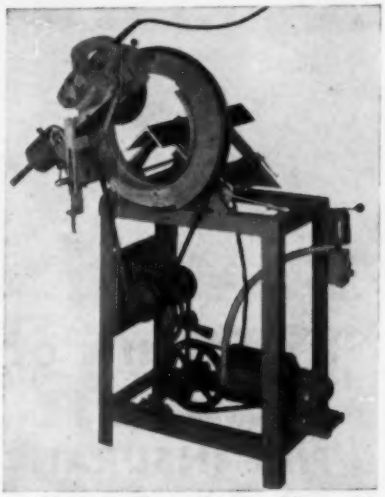
Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers of Mathews Hydrants and "Sand-Spun" Pipe (centrifugally cast in sand molds)

New Cut Machining Unit

1106

Wallace Supplies Mfg. Co., Chicago, Ill., has developed a new low cost machine which cuts as it "rolls-a-round."



This versatile cutting machine, with a wide range of both pipe or tube and structural shapes is available in two stock sizes. 6⅝ in. O.D. hollow sections or such shapes as will fit into 6 in. circle, and 12⅝ in. O.D. hollow section (such as pipe or tube) as well as structural or special sections which will fit into 12 in. circle.

Electrical power is controlled through a drum type reversing switch making rotation of the cutting unit simple and positive. A variable drive system permits a proper selection of speed of rotation of the cutting head around the work.

Teflon-Faced Diaphragm For Diaphragm Valves

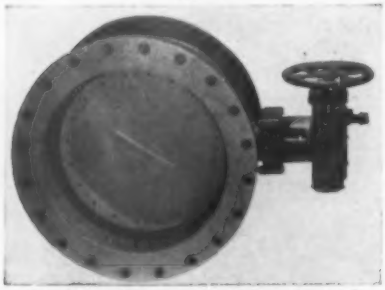
1107

Hills-McCanna Company, Chicago, Ill., has announced a new Teflon-faced diaphragm of one-piece construction for use in Hills-McCanna Diaphragm Valves.

This new diaphragm is made with a solid Teflon sheeting, permanently bonded to the face and external edges of an elastomeric backing, and provides for corrosion protection from both the internal flow and external atmospheric conditions. This construction combines the chemical resistance of the solid Teflon diaphragm and the hydraulic shock absorbing flexibility of elastomeric type diaphragms. The new diaphragm also features Hills- McCanna sealing bead construction for positive closure under pressure or vacuum at operating temperatures ranging from —10°F to 240°F and line pressures up to 150 PSI.

New Type Butterfly Valve

1108



Darling Valve & Manufacturing Co., Williamsport, Pa., has announced the production and immediate availability of a new line of butterfly valves, featuring a unique rubber seating principle and unusual operating characteristics.

Manufactured under licensing agreement with the designer, Pelton Div. of the Baldwin-Lima-Hamilton Corp., the new rubber seated valves are tradenamed Darling-Pelton Butterfly Valves and have the benefit of extensive laboratory and field testing by both the Pelton and Darling organizations.

Advantages claimed for this new type of butterfly valve include: lower operating torque, adjustability of seat for tight shutoff, seat replacement without removal of shaft or operator, elimination of shaft sealing problems as the rubber seat is a continuous ring integral with the disc, and, increased operating cycles before part replacement or maintenance is necessary.

This line of butterfly valves, now extends from 4" to 72" sizes for pressures in the 50 to 250 psi range. The valves are designed for all types of manual and air or hydraulic cylinder operation.

Lift Jacks and Platforms Cut Bag Handling Costs

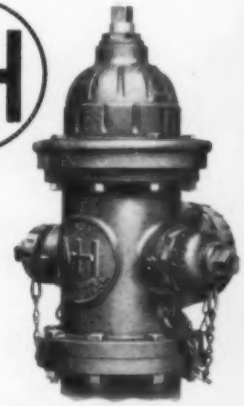
1109

Bond Foundry & Machine Co., Manheim, Pa., has announced that the Lancaster Water Authority, Lancaster, Pa., has reduced their operating costs by using Bond lift jacks and platforms in their Conestoga Filtration plant to handle 100-lb. bags of alum.

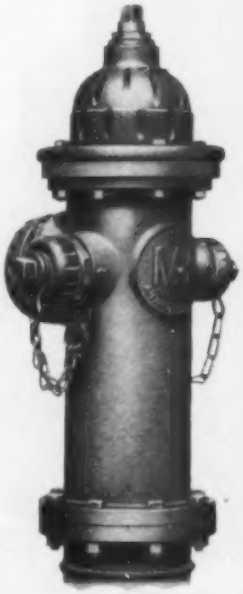
The Authority found that by using the Bond lift jack and platform system, that the bags of alum required only one handling, from the delivery truck to the platform truck. Once on the platform truck, the load—18 of the 100-lb. bags of alum—is put on an elevator and moved to the storage area. When alum is needed in the process, one man using the lift jack, takes a loaded platform truck over to the feed bin. The old handling system, the Superintendent of the Authority indicates, required ten men for unloading, the new Bond system requires only six men. In addition, their inventory control is simplified, they need less space for storage, and yet always have an adequate stock for suppyling the necessary material in the process on a non-continuous basis.

The mark of LOWER FIRE INSURANCE RATES

MH



Standard model



Traffic model

Along the streets of hundreds of U. S. villages, towns and cities stand modern sentinels of fire protection: M & H fire hydrants. Where you see them, too, you can be reasonably sure they are the mark of lower fire insurance rates. Assuming an adequate water supply, an efficient distribution system and a fire department, M & H hydrants are the last of the four principal factors which mean good fire protection and lower insurance rates.

An M & H hydrant may long stand idle, yet functions perfectly when needed. Large inside diameter and unobstructed waterway gives high flow efficiency. Operating parts are bronze or bronze bushed. Furnished either UA & FM approved or A.W.W.A. specification, standard model, traffic model or flush type. For complete information, address

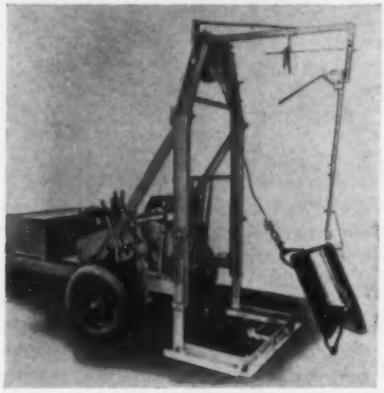
M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

SUBSIDIARY OF W WALWORTH

Automatic Bucket Dumper For Sewer Cleaning Machines

1110

Flexible Inc., Los Angeles, Calif., has introduced a new Automatic Budget Dumper for bucket machines.



The new device eliminates the need for a standby helper to dump the bucket when it comes out of the sewer. The firm estimates the savings in wages can pay for a set of two bucket machines in approximately one year.

The device operates simply. A hook arm picks up the full bucket, swings it out, opens the bucket automatically and dumps the load, then returns the bucket to pick-up position. It is not only optional on all new Flexible bucket machines but can be easily installed in 30 min. on machines now in use.

Product for Reducing Water Evaporation Available for Field Trials

1111

American Alcolac Corporation, Baltimore, Md., has developed a product which reduces the evaporation of water by forming a monomolecular film barrier on the surface of the water. Samples are available without charge for field tests by water districts, municipalities, industrial concerns, and other organizations and individuals interested in water conservation.

A special combination of fatty alkanols, trade-named Siponol EGH, the new product is said to reduce evaporation as much as fifty percent under favorable conditions. It is supplied as a five-pound slab, together with accessory attachments so that it may be anchored in a definite position on the surface of the water.

The monomolecular film is established automatically by spreading out radially from the slab until confined by a physical barrier—e.g., shoreline, tank edge. Back pressure then stops

(Continued on page 102A)

NOW...provide *COMPLETE* containment of water, wastes, brines and sludges with

SEALTIGHT **Hydromat** ASPHALT LINERS

Pre-fabricated "HYDROMAT" Asphalt Liners provide the ideal liner for all domestic, industrial and recreational facilities where the containment of water, wastes, sludges, brines, etc. demand a very efficient, economical and impervious lining material. "HYDROMAT" is quickly and easily installed as a monolithic liner with mechanically sealed joints . . will expand and contract with soil movements without rupturing or breaking the seal. Installed over (exposed) or under earth, concrete, gunite, steel or other materials... provides the practical answer to the problem of re-lining old, cracked concrete or gunite linings. "HYDROMAT" may be safely used for the containment of potable water in clear well construction and its ruggedness and durability permit its use as a fully exposed lining in large reservoirs to depths exceeding 50 feet. "HYDROMAT" is available in three thicknesses, ½", ¼" and 5/32", in 4' widths and lengths up to 15' . . . longer lengths available on special request.

For complete installation and technical data write today for your copy of the "HYDROMAT MANUAL".

SEALTIGHT PRODUCTS FOR BETTER CONSTRUCTION

W. R. MEADOWS, INC.

7 KIMBALL STREET
ELGIN, ILLINOIS

W. R. Meadows, Inc.
7 Kimball Street, Elgin, Illinois

Gentlemen:

☐ Send my copy of the "HYDROMAT MANUAL".

☐ Have representative call.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

further spreading of the material, the remaining portion of the slab acting as a reserve to repair breaks in the film and replenish film that is lost.

Although the film is only one ten-millionth of an inch thick, it prevents the escape of water molecules to the atmosphere. At the same time, it is permeable to oxygen, so that aquatic life is undisturbed by its presence.

The monomolecular layer is a durable surface film that resists wind action. If it is broken by a strong prevailing wind, the film quickly reforms on change in direction or cessation of the wind. Similarly breaks caused by humans, animals, fish, rain or miscellaneous objects are continually repaired by the spreading action of the Siponol EGH. In addition, since the material is resistant to bacteria attack, it is long lasting.

Packless Diaphragm Pump For Metering and Proportioning

1112

Hills-McCanna Co., Chicago, Ill., has developed a new concept in packless diaphragm pumps for porportioning and metering fluids. Thoroughly tested under actual operating conditions, this diaphragm pump performs with exceptional accuracy and minimum maintenance at pressures up to 2,500 psi.

Its Teflon-faced diaphragm is a new development by Hills-McCanna. The diaphragm consists of solid Teflon permanently bonded to, and covering, the face of an elastomeric backing. This type of construction assures long diaphragm life by combing the chemical resistance of Teflon with the flexibility of an elastomeric backing.

Vertical Hollow-Shaft Motors For Hazardous Installations

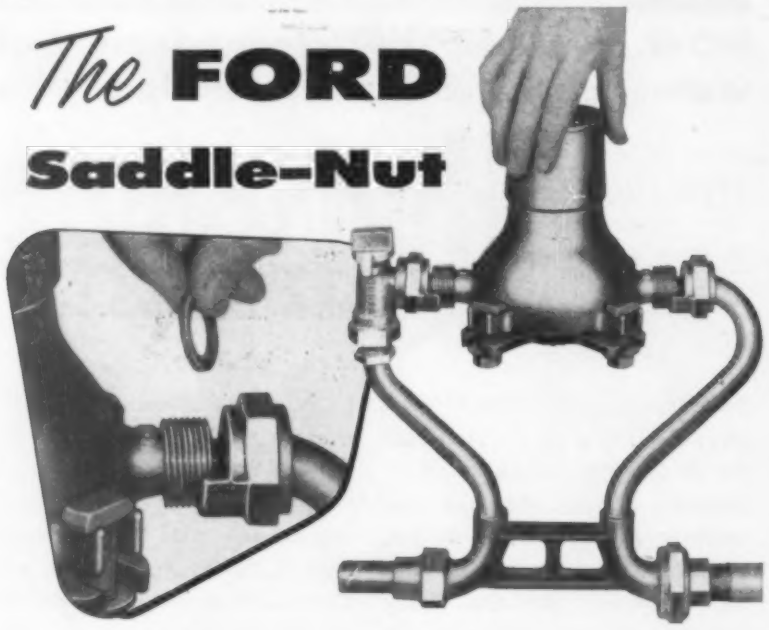
1113

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has announced that Underwriters' approved A-C vertical hollow-shaft motors in frame size 180 through 30 are now available in totally-enclosed and explosion-proof designs for hazardous locations or installations where excessive heat and dust require added protection.

Hollow-shaft motors by Allis-Chalmers are available in ratings to 700 hp in all types of enclosures including open, totally-enclosed, fan-cooled, and explosion-proof with either rigid or self-release couplings. Non-reverse protection is also available.

Courtesy Atlanta Water Works "Willing Water")

"I'll bet she's either listening in on the boss, or calling her favorite bookie."



The FORD Saddle-Nut

HOLDS the meter for you!

Save time . . . . Save trouble . . . . Save gaskets, by putting the FORD SADDLE NUT at inlet, or both ends of every meter installation.

The patented Ford Saddle Nut has a supporting lip extending about half way around the meter nut, so that it supports the weight of the meter, lines up the threads of the nut with the meter spud, and provides a place to hold the gasket before the nut is screwed onto the meter.

The Ford Saddle Nut is available on all Coppersetters and Resetters at a small additional cost.

Send for Complete Information.

FORD FOR BETTER WATER SERVICES

THE FORD METER BOX COMPANY, INC. Wabash, Indiana

W&SW
MANUFACTURERS NEWS

Anable Rejoins Dorr-Oliver

Dorr-Oliver Inc., Stanford, Conn., has announced that Anthony Anable has rejoined the staff of the Company as Manager of the Technical Data Division with headquarters in the general offices at Stamford. Prior to his return he was, for the past few months, retained as a consultant to the Company in connection with completion of a training program for new technical personnel.

Mr. Anable has been a member of the staff of Dorr-Oliver in various capacities ever since graduating as a chemical metallurgical engineer from Massachusetts Institute of Technology, except for a year and a half period beginning in August 1955.

Slusser Joins Climax In California

Climax Engine Manufacturing Co., Chicago, Ill., has announced the appointment of James K. Slusser as district representative for the State of California. He will maintain headquarters at Westminister, California.

Mr. Slusser is a graduate of the City College of Long Beach and has specialized in engine sales and applications for several years.

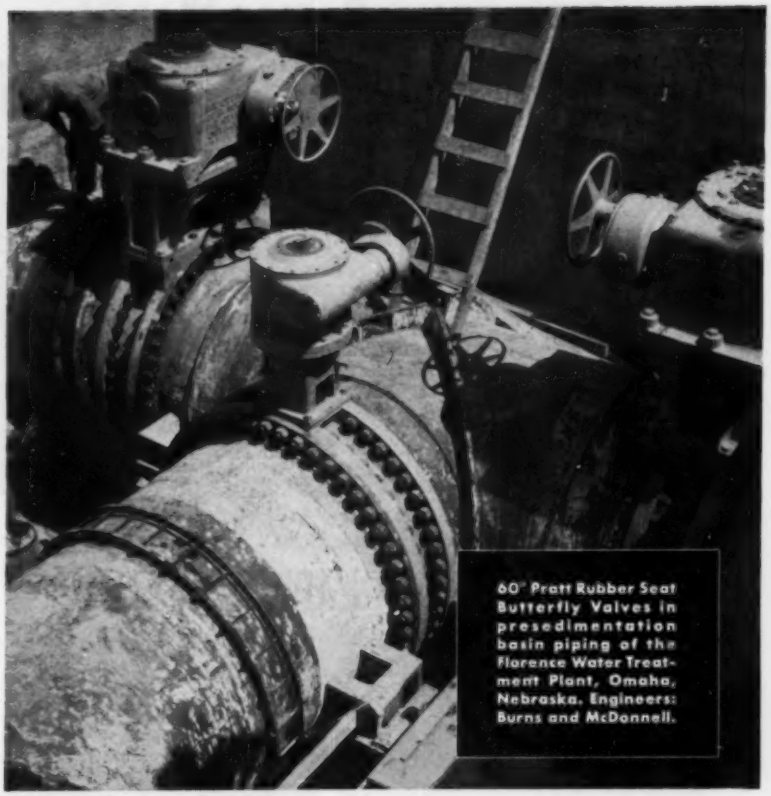
Fischer & Porter Names Regional Managers

Fischer & Porter Company, Hatboro, Pa., has named managers for its newly organized eastern, southeastern and southwestern sales regions.

Harold Russell has been named manager of the eastern region, comprising the New York, Philadelphia, Boston, Baltimore-Washington, Richmond, and Albany-Syracuse offices. Mr. Russel was formerly Sales Engineer for major industrial accounts, working out of the New York office.

William Trethaway will manage F&P's southeastern area, to include the Atlanta, Birmingham and Knoxville offices as well as two offices in Florida at Clearwater and Jacksonville. Mr. Trethaway joined Fischer & Porter

(Continued on page 104A)



60" Pratt Rubber Seat Butterfly Valves in presedimentation basin piping of the Florence Water Treatment Plant, Omaha, Nebraska. Engineers: Burns and McDonnell.

OMAHA... Butterfly Valves are key to compact piping

This ultra-compact arrangement of three 60 inch valves could only be made with Butterfly Valves. The illustration shows the narrow face-to-face dimensions (only 15") and the compactness of the valve-operator assemblies. What you can't see is equally important! The rugged internal construction—the rubber seat that is never under severe pressure from the valve disc, only partially displaced during closure... features that mean years of easy operation without maintenance problems or costs.

Pratt originated the Rubber Seat Butterfly Valve and has installed more of them than any other manufacturer.

For valve design with a 50 year reputation for practical imagination, see Henry Pratt.

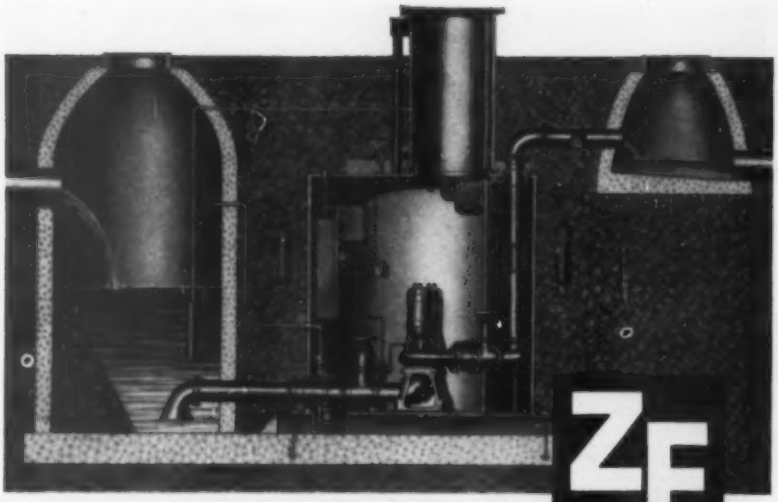
NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.

Write for Manual B-2B

HENRY PRATT

RUBBER SEAT
Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities



Before engineering your sewerage system consider the advantages of this . . .

PREFABRICATED PUMPING STATION

- Installation can be made with a minimum of time and cost.
- Can be installed on existing public property.
- Entire unit is prefabricated and shop-fitted with standard, well-known equipment.
- Usually can be located at most advantageous spot for existing gradients.
- It is feasible to move and relocate should conditions change.
- Improved equipment, controls and prefabricating technique make the Z-F Station an economical and reliable unit. Write for details.

(Territories open for representatives)

Manufactured by ZIMMER & FRANCESCON, Moline, Illinois

GUNITE does it 2 times as fast at 1/2 the cost

"Gunite" is the modern process (sand and cement applied pneumatically) for repairing, constructing, lining:

- Reservoirs
- Dams
- Filter Plants
- Sewage Disposal Plants
- Tanks
- Stadiums
- Bridges
- Sea Walls
- Swimming Pools, etc.

WRITE FOR MORE INFORMATION, INCLUDING 48 PAGE "GUNITE" BOOKLET.

PRESSURE Concrete Co.

FLORENCE, ALA. 1555 Helton Street

OTHER OFFICES IN

CHICAGO, ILL. 30 W. Washington Street

NEWARK 5, N. J. 193 Emmet Street

in 1951, serving in the engineering department before his initial sales appointment to the Atlanta office.

Glen Dorflinger has been given charge of the southwestern region which includes offices in El Paso, Dallas, Houston and New Orleans. Mr. Dorflinger was formerly manager of F&P's Houston office.

Climax Engine Changes Name

Climax Engine Manufacturing Co., Chicago, Ill., a Division of Eversharp, Inc., has been announced as the new name of the company formerly known as Climax Engine & Pump Mfg. Co., a Division of Eversharp, Inc.

It is further announced that the District Office at Dallas, Texas has been moved to the Tower Petroleum Building, 1907 Elm Street, Dallas 1, Texas from a former location at 155 Continental Avenue, Dallas 7, Texas.

The company maintains general sales offices at 208 South LaSalle Street, Chicago, Illinois and a factory at Clinton, Iowa. Distributors are located at strategic points throughout the United States and Canada.

M-H Valve Division Moves To New Plant

Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., has opened a new $1.5-million plant in Fort Washington, Pa., for the production of industrial valves.

The 120,000 sq. ft. plant, located on a 25-acre site in Fort Washington's Industrial Park, 12 miles north of downtown Philadelphia, provides manufacturing, research and development, sales and administrative facilities for Honeywell's Valve Division.

The new one-story plant is designed so that it can be expanded to more than three times its present size. From two to three weeks will be required to transfer machinery and other equipment from the old site occupied since 1856 on Broad Street, six blocks from Philadelphia's City Hall.

Hersey Names Sapsford And Leavell

Hersey Mfg. Co., Boston, Mass., has announced that Robert O. Sapsford of Charlotte, North Carolina, has

been named North Carolina representative for the company.

Mr. Sapsford resides at 1115 Leigh Avenue, Charlotte, but will operate from the Atlanta, Ga., branch office.

At the same time it was announced that Manly B. Leavell of Jacksonville, Fla., would represent the company in the State of Florida.

Mr. Leavell will continue to operate from the company's Atlanta branch headquarters.

Dresser Completes New Plant

Dresser Manufacturing Division of Bradford, Pennsylvania, has, announced the completion of a new million dollar compression fitting plant in Wellsboro, Pennsylvania.

The new plant, providing 100,000 square feet of manufacturing space, is devoted exclusively to the manufacture of compression fittings. The plant, to employ 250 people when full production is attained, is equipped with specially designed, high speed, largely automatic machinery.

Another phase of Dresser Manufacturing Division's expansion program is taking place at the Bradford plant which has been enlarged with an addition of 33,000 square feet of space. This coupled with a complete relocation and modernization of existing production lines will increase production of couplings, repair clamps and sleeves, saddles and other products by 15 per cent.

Clay Pipe Association To Build New Research Laboratory

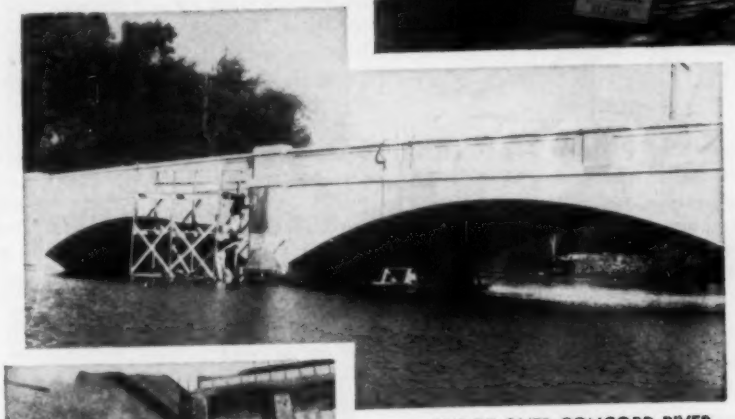
The National Clay Pipe Manufacturers Association, Cleveland, Ohio, has announced that they will build a new research building and laboratory facilities to house the industry's research program.

The new laboratory will be located in Crystal Lake, Illinois, 43 miles Northwest of Chicago. Five acres of land have been acquired on Route 176 near the city limits of Crystal Lake. Construction of the building will begin in a few weeks.

For several years the industry research laboratory has been located in Los Angeles, California. In addition to work done in this laboratory, other projects have been assigned to industrial research organizations and universities throughout the country. The construction of the new laboratory will serve to centralize the research effort of the industry so that work on related problems can be concentrated in one location.

It's New Again with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.



BRIDGE OVER CONCORD RIVER
ROUTE 3, BELLERICA, MASS.

Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Nonslump 20-Minute Set Patching Mortar*, without necessity of costly forming, finished by application of Thoroseal.

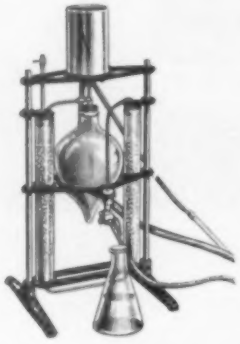
Request Circular No. 16 and 20.

Write for our 16 page "How to Do It"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA • CENTERVILLE, INDIANA

ENSLOW

STABILITY INDICATOR



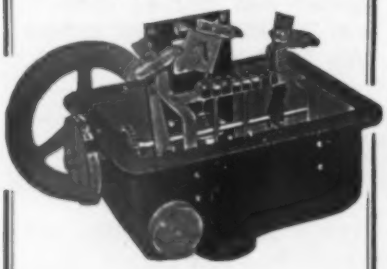
For checking the equilibrium of a finished water, and supplying an index useful in controlling anti-corrosion treatment. Catalog No. 83-895

WRITE:

Phipps & Bird, Inc.

P. O. Box 2V Richmond 5, Va.

ROTO-TROL



RF-2

WITH ALTO-TROL

This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles.

The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

Write for full data

WATER LEVEL CONTROLS DIVISION

HEALY-RUFF COMPANY

783 Hampden Ave., St. Paul 4, Minn.

W&SW

New Literature

Safety Equipment

1114

General Scientific Equipment Co., Philadelphia, Pa., has just published a catalog that presents the company's entire line of **Safety Equipment** in an easy-to-use buyers'-guide arrangement.

The catalog includes all types of protective equipment—from a small half-ounce dust mask to a large barrel lifter. Nearly all of the several hundred listed items are illustrated; general specifications and recommended uses are given for each.

Equipment is grouped according to its function so that the reader can compare similar products and select the ones best suited to his needs. Product descriptions are completely factual and sufficiently detailed to permit a proper choice.

Liquid Strainers

1115

Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has just published a bulletin on **Self-Cleaning Liquid Strainers.**

According to this bulletin the Banks continuous strainer, as manufactured by Golden-Anderson, is especially designed for the straining of fluids without itnerrupting the flow for cleaning the screen. Since the screen is constantly kept clean, small perforations of .023" diameter are used, which effectively stop the smallest of troublesome particles.

Standard Motor Bulletin

1116

Sterling Electric Motors, Inc., Los Angeles, Calif., has just published a 12 page colored brochure describing the complete Sterling line of **Standard Electric Motors.**

The bulletin illustrates several electric motor applications and contains much valuable selection information. Many of Sterlings' exclusive design advantages are described and the entire range of Sterling Electric Motors are illustrated. In addition to the complete standard motor line outlined in the new bulletin, Sterling also manufactures a wide range of Slo-Speed Gear Motors and Speed-Trol Variable Speed Motors.

Synonym for...

PURE WATER

ROBERTS FILTER

MANUFACTURING CO.

607 COLUMBIA AVE.

DARBY, PA.

Surer Gland Lubrication for Centrifugal Pumps

THE Z-F GREASE SEAL eliminates that trouble spot where shaft enters casing. Applies constant positive lubrication to packing and shaft—automatically. Excessive heat, rapid wear, leakage and scoring will disappear as the Grease Seal applies a constant flow of lubrication when pump starts until it stops—automatically. Many other advantages, too. Write for complete description and price. **ZIMMER and FRANCESCON, Moline, Illinois.**

ZF

Meters and Controls
1117

Bailey Meter Co., Cleveland, O., has just published a new 8-page, 1957 edition of the **Bailey Meter Annual Bulletin** that presents all the instruments introduced within the last year.

Applications, ranges, and detailed literature references are given for the complete line of Bailey transmitting, recording, indicating, and controlling instruments.

Ground Water Movie
1118

Layne & Bowler, Inc., Memphis, Tenn., has available a full color and sound 16 mm motion picture on ground water development. The film is titled **"Deep Waters."**

The film portrays how water reaches the underground formations with animated sequences of underground processes which could not be photographed; how water is located and the processes necessary for its production in ample quantities; it shows drilling rigs in action, setting and cementing, casing, setting and graveling screen and test pumping the well. The film runs 22 minutes and is available to interested groups for showing without cost.

Utility Ditcher
1119

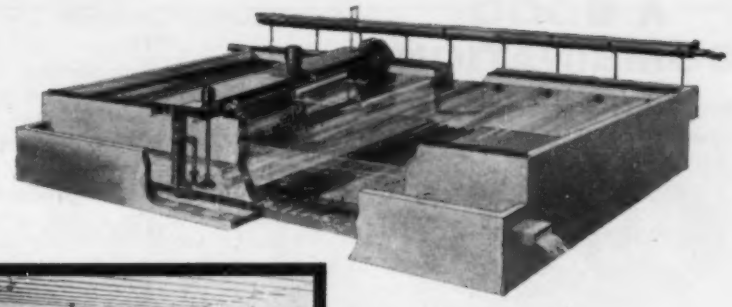
Gar Wood Industries, Inc., Wayne, Mich., has just released a new catalog, featuring the improved Gar Wood-Buckeye **Model 403 Utility Ditcher.**

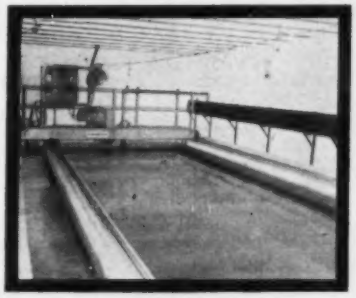
This colorful, 8-page catalog is thoroughly illustrated with mechanical views of all major components. Action photos, showing the ladder-type ditcher at work under a variety of conditions are also included.

Transmission Equipment
1120

The Jeffrey Manufacturing Co., Columbus, Ohio, has available a new 88 page catalog featuring **Jeffrey Transmission Products** and their uses in elevating and conveying machinery.

Descriptive information with drawings and tables of dimensions covers a variety of shaft collars, couplings, clutches, pillow blocks, take-ups, wheel hubs, gears, holdbacks, chains and sprocket wheels.





12½′ x 40′ Hardinge Automatic Backwash Sand Filter in a municipal water plant in Vermont.

12½′ x 86′ Hardinge Filter handling water supply for a Canadian paper plant.

A sand filter which

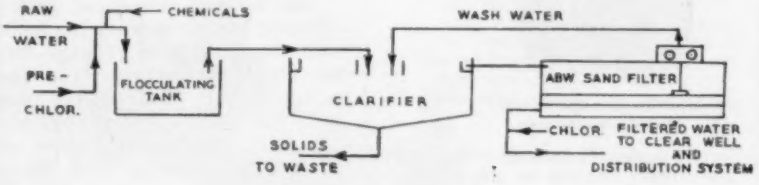
CLEANS ITSELF

The Hardinge Automatic Backwash Sand Filter is a complete departure from standard filtration equipment, in that it backwashes its filter bed automatically without interrupting normal filtration.

The ABW filter in combination with flocculation and sedimentation equipment provides treated and filtered water for municipal and industrial water supplies.

The filter may be applied also for the treating of plant waste water, for reuse or disposal.

Complete specifications upon request. Bulletin 46-A-15.



The flow sheet above illustrates the use of a Hardinge ABW Filter, in conjunction with Hardinge flocculating and clarifying equipment, on municipal or industrial water treatment. A modified system is available for liquid waste disposal or reclamation.

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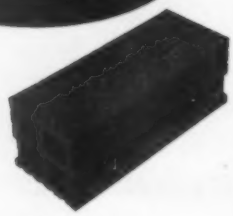

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Sweco Surface Condenser
1121

Southwestern Engineering Co., Los Angeles, Calif., has just published an illustrated bulletin describing its new line of **Surface Condensers.**

Designed for efficient production of vacuum for prime mover service with large steam turbines, these surface condensers offer the new "Delta Vee" design. The bulletin is prepared in two-colors and is well illustrated to show design and technical features.

General Service Pumps
1122

Economy Pump Div., C. H. Wheeler Manufacturing Co., Philadelphia, Pa., has just published a four-page, two-color catalog describing the company's line of redesigned **General Service Pumps.**

Arcording to the catalog the pumps, designated as Type EUG, are used for the removal of solid-free drainage and seepage from low to high levels. Inside the brochure is a large cutaway drawing of a typical EUG Pump, with details of 17 construction features. The bulletin also contains metallurgy information, general data on performance and sizes, and details on pump accessories.

Large Clay Pipe
1123

Robinson Clay Product Co., Akron, Ohio, has just published a new, four-page brochure, **"Big Pipe by Robinson".**

This file-size two-color, fully illustrated brochure describes Robinson's complete lines of large diameter clay pipe, fittings, and time-saving factory-made joints. Sizes and descriptions of both standard and extra-strength clay pipe with pre-cast Slip-Joint and Wedge-Lock Joints are included. Allied products described include wall coping, liner plates, ventilator caps and pipe covers, refractories, and Staminite acid-proof cement.

Drafting and Computation Shortcuts
1124

Frederick Post Co., Chicago, Ill., has just published a booklet on **Time Saving Tips for the Draftsman and Engineer.**

This booklet contains a total of 59 interesting tips and drafting shortcuts suggested by leading en-

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Included in the booklet are 22 drafting shortcuts, 9 easy-to-use, practical shortcuts to formulas and other engineering data, and 18 board timesavers.

Pipe Line Mixing
1125

New England Tank & Tower Co., Everett, Mass., has available a bulletin on the **Nettco Flowmix.**

This 4-page, 3-color, bulletin describes and illustrates how the "Flomix" is designed to be installed in a pipe line to mix liquids flowing through the line. According to the bulletin, the unit utilizes every mixing feature of frictional flow by repeated dividings, reversings, and combinings of the entering flow; coupled with violent mechanical agitation, results in an intimate contacting that guarantees homogenous results.

A cut-away drawing illustrates the mixing actions that take place within the "Flowmix." A table of dimensions and motor sizes completes the bulletin.

Controlled Volume Pumps
1126

The Milton Roy Company, Philadelphia, Pa., has released a Bulletin on **H20® Controlled Volume Pumps.**

The new controlled volume pump, available in simplex or duplex models, is engineered to provide low-cost metering and pumping of non-corrosive liquids at normal temperatures with repeatable accuracy. Typical applications include boiler feed water treatment, cooling tower water treatment, feed-to-process of various chemicals and process water treatment systems.

The bulletin contains complete specifications, design features, di-Barrel Pumps are also illustrated mensions and ordering data. Milton Roy Packaged Systems and and described.

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Plastic Pipe Fittings and Valves
1127

Sloane Mfg. Co., Sun Valley, Calif., has just published a new illustrative brochure and stock catalog on **Plastic Pipe Fittings and Valves.**

The brochure features: Latest information on plastic pipe fittings and valves; Data and illustrations on various plastic pipe fittings including—tees, ells, 45° ells, side outlet ells, couplings, male adapters, female adapters, reducer bushings, nipples, clamp saddles, caps, plugs, and flanges; Detailed diagram and description of standard plastic valves.

Extending Cooling Tower Life
1128

The Milton Roy Co., Philadelphia, Pa., has released a new **Application Engineering Data Sheet.** This four-page data sheet describes several methods of combating corrosion and delignification in cooling towers, using controlled volume pumps to meter precise quantities of chemicals to cooling water.

This data sheet features complete details and drawings explaining continuous pH control using Mersemetric pumps, acid metered in proportion to flow rate, chemical feed with automatic level control and other low-cost cooling tower water treating systems.

Rigid Polyvinyl Chloride Pipe
1129

Alpha Plastics Inc., Livingston, N. J., has just published a 12-page two-color catalog on **Alpha Pine, Fittings and Valves.**

Included are tables of pipe sizes available, specific chemical applications, physical properties, temperature factors for various working pressures, support spacing and thermal expansion.

Flow charts, installation instructions, pipe characteristics and fields of application are also included.

White Superior Diesels
1130

White Diesel Engine Div., The White Motor Co., Springfield, Ohio, has just issued a bulletin on the Model 60 and Model 80 **Superior Stationary Diesels.**

The literature lists the engines as designed to provide low speed power for continuous, heavy-duty service. Engines are four-cycle, six or eight cylinder, in-line models, ranging from 530 to 2000 BHP and from 300 to 1250 KW, are available either naturally aspirated or supercharged, and can be furnished to run as diesel, dual-fuel, or gas engines.

The 12-pg., two-color bulletin includes products photographs, illustrated construction features, dimensions data, performance curves, and specifications.

Walking Beam Flocculators
1131

Stuart Corp., Baltimore, Maryland, has just published a Question and Answer booklet on Walking Beam Flocculating Equipment.

This very informative booklet was designed to answer most of the questions arising from both the consulting engineer and the plant superintendent. It discusses all phases of the equipment operations from "Where the equipment can be used" to the power requirements.

The center of the booklet contains a 2-page line drawing showing a cutaway view of a complete Walking Beam installation with keyed text pointing out the main features. The booklet also presents a brief summary of optional equipment features.

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SEWAGE PLANT SUPERINTENDENT

The City of Roanoke, Virginia has available as of October 1, 1957 a position as Plant Superintendent, Sewage Treatment Plant.

Salary Range—$420.00 - $540.00 per month (1956 Job Class. Comm. Report).

Position carries Pension Plan, Sick Leave, and Vacation. Retirement age 65.

Qualifications: Should have B.S. in Sanitary, Civil, or Chemical Engineering and possess at least 5 years' operational experience in an activated sludge plant. (Sect. 110-3, Job Description, City of Roanoke.)

Plant Data: Type: Standard Activated Sludge Process
Capacity: Design: 14.00 M.G.D. including 25% Return
Present: 11.47 M.G.D. plus 39% Return
Number of Personnel: 19

Application accompanied with photograph to be made to Mr. A. S. Owens, City Manager, setting forth training and experience.

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The position assists the Superintendent of Water and Sewers in the administration of the water and sewage system.

Considerable experience in a progressively responsible technical and administrative capacity including engineering and operations experience in a water utility and sewage system. Graduation from a four-year college or university with specialization in Civil, Mechanical or Sanitary Engineering. Eligible to be registered in the State of Arizona. An applicant for Arizona registration shall be age 25 or over and have 8 years engineering experience for which up to 5 years of training or teaching in engineering may be equated.

$725-$795 per month.
Age Limits—25 to 55.
Apply by November 1, 1957 to:

Leroy J. Brenneman
Personnel Director
City Hall Phoenix, Arizona

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Sanitary Engineers II and III; salary ranges $460-$575, $575-$725 respectively; two to four years' experience in public health or sanitary engineering; excellent retirement and fringe benefits; liberal leave policy and travel allowances. Write Personnel Officer, Florida State Board of Health, P. O. Box 210, Jacksonville 1, Florida.

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